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Edited by

Eldon Y. Li
Peter Ractham
Benjamin Yen

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*Volume 22***

*“New Challenges and Opportunities for
Post-Pandemic E-Business”*

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National Chung Cheng University

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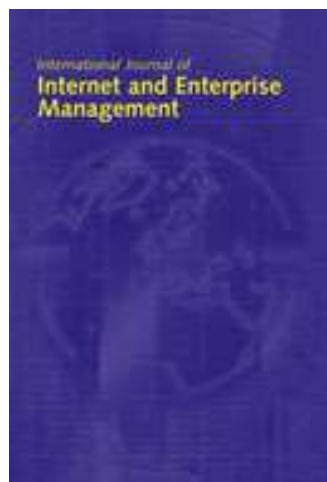
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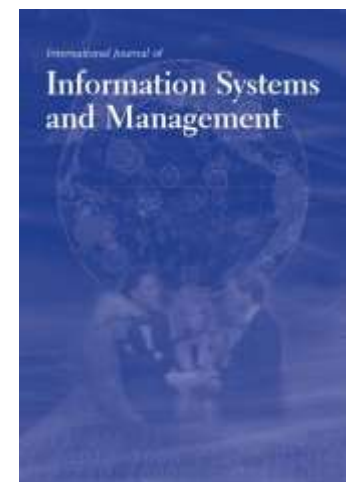
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PREFACE

Welcome to the Proceedings of the 22nd International Conference on Electronic Business (ICEB 2022). Celebrating its 22nd anniversary, the ICEB is held again this year in hybrid mode, virtually by the University of Hong Kong Business School and physically by the Thammasat University Business School in Bangkok, Thailand. This year's conference theme is “*New Challenges and Opportunities for Post-pandemic E-Business*”. We received 102 submissions, and 91 papers were accepted into the final program, which consisted of 28 sessions. The topic areas of the papers in this conference include artificial intelligence (AI) and its applications, Big data analytics and business intelligence, blockchain and its applications, collaborative commerce and sharing economy, COVID pandemic e-business issues, cross-border e-commerce, digital marketing and consumer behavior, digital transformations in enterprises, e-entrepreneurship and innovations, e-healthcare and gerontechnology, e-learning and COVID-19, ESG and public issues, finance-related issues, HRM-related issues, knowledge management and sharing, new technology adoption and diffusion, smart cities and Internet of things, smart homes and smart technologies, social media and social computing, strategies and models of e-business, supply chain management, and e-logistics, virtual communities and social commerce, web mining and recommendation systems, and other interdisciplinary issues. In this proceedings book, we have included 56 full papers and 20 work-in-progress papers.



At the conference, we have scheduled five keynote speakers (in the sequence of appearance): Prof. Matthieu Guitton, the Chief Editor of *Computers in Human Behavior*; Prof. Robert M. Davison, the Chief Editor of *Information Systems Journal*; Prof. Chris Rowley, the Chief Editor of *Asia Pacific Business Review*; Prof. Chris Westland, the Chief Editor of *Electronic Commerce Research*; Prof. Alain Chong, the Co-Chief Editor of *Industrial Management & Data Systems*. They all welcome the authors of full papers in this conference to submit papers to their journals for publication. Because of the COVID-19 pandemic, all keynote speeches and presentations are delivered with ZOOM software in two virtual meeting rooms. This year's speeches are scheduled in two days, considering the time zone differences between the 5 speakers in Canada, Hong Kong, London, Chicago, and China, respectively. Presentations are also scheduled carefully to allow authors from different continents to attend the meetings between 9:00 AM and 6:30 PM in Hong Kong time.



The annual conference of ICEB is an excellent opportunity for scholars like you and me to share research ideas and get informed about the latest development in related fields. In addition, we could meet leading scholars from around the world to establish a research network and engage in future collaborations. In this conference, there are 96 registered scholars from 26 countries or regions, including Australia, Brazil, Canada, China, Finland, Germany, Hong Kong, Hungary, India, Indonesia, Iran, Japan, Morocco, New Zealand, Philippines, Singapore, South Africa, South Korea, Sweden, Taiwan, Thailand, United Kingdom, Vietnam, and others. This year, the Best Paper Award Committee of 6 members selected one best and 6 outstanding papers to receive the awards.

On behalf of the entire Conference Committee, we thank you for participating in ICEB 2022 hybrid conference. Without your presence, the conference could not be so successful. We also thank all the speakers, presenters, reviewers, program committee members, Best Paper Award committee members, and session chairs who have contributed their time and effort to this conference. Furthermore, special thank goes to Prof. Benjamin Yen and his conference team from the University of Hong Kong, who provided the administrative and technical support to execute the ZOOM conference events tirelessly and flawlessly. Also, we thank Ms. Yunu Chen of Plum Season Co., who helped our home office setup and manage the payment gateway effectively with ACCUPASS. Finally, we thank the Publication Manager, Dr. Robert Louis Forestal, for his professional editorial services and you, the authors, for preparing and sharing your research findings in the presentation meeting sessions.



Last but not least, we look forward to seeing you again in ICEB 2023 at the National Chung Cheng University in Chiayi, Taiwan, October 13-17, 2023. Until then, have a wonderful and productive year!

Sincerely yours,

Eldon Y. Li

Eldon Y. Li
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Chair Professor of MIS
National Chung Cheng University, Taiwan

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Peter Ractham
ICEB 2022 Conference Co-Chair
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October 2022 in Bangkok, Thailand

TABLE OF CONTENTS

TITLE	PAGE
Preface <i>Eldon Y. Li, Peter Ractham & Benjamin Yen</i>	<i>i</i>
PART 1: Full Research Papers	
1. “Share for bargaining?”: A willingness model based on privacy computing theory <i>Zhonghang Li, Feng Liu, Tao Liu & Zixuan Zhou</i>	<i>1</i>
2. A mediation–moderation framework of consumers’ intention to participate in crowdfunding <i>Mathupayas Thongmak, Nopporn Ruangwanit & Noptanit Chotisarn</i>	<i>13</i>
3. An analysis of youtuber’s collaboration towards audience engagement <i>Sukritta Hankunaseth & Winai Nadee</i>	<i>27</i>
4. An economic analysis of software piracy in a competitive cloud computing market: A product bundling perspective <i>Zhiyuan Liu, Yuexiang Yu, Jikun Lv & Xiong Zhang</i>	<i>35</i>
5. Competence recharging in the pandemic: The role of social support, motivation, organizational culture, and self-awareness <i>Gita Aulia Nurani, Susatyo Yuwono, Achmad Dwityanto & Rizqi Zulfa Qatrunnada</i>	<i>45</i>
6. COVID-19 accelerated digital transformation: The case of Meituan <i>Minyi Huang, Yixin Jian & Benjamin Yen</i>	<i>54</i>
7. Developing and validating a scale to identify the employability skill set vital for the frontline workers: A case of hospitals in Delhi/NCR <i>Swati Sisodia & Neetima Agarwal</i>	<i>63</i>
8. Digital inequalities at high schools in Thailand: A survey-based exploration leading to expert-backed bridging strategies <i>Bob Nanthakorn, Peter Ractham & Phatsaporn Suwannakart</i>	<i>76</i>
9. Disney plus Hotstar on Twitter: Using netnography and word clouds to gain consumer insights. <i>Prerna Arora, Anurupa Bagchi Singh & Vandana Ahuja</i>	<i>85</i>
10. Exploration of the consideration factors of pure e-commerce business for transforming into new retail model <i>Shiang-Lin Lin & Bo-Yi Li</i>	<i>97</i>
11. Exploration the future of the metaverse and smart cities <i>Jie Wang & Gabriella Medvegy</i>	<i>106</i>
12. Exploring enterprises competition: From a perspective of massive recruitment texts mining <i>Lu Liu, Jiaming Fang & Liangqiang Li</i>	<i>116</i>
13. Factors influencing intention to purchase through VR platforms <i>Sarocho Muensit & Mathupayas Thongmak</i>	<i>133</i>

14. Factors influencing patient's medical choice behavior on internet medical: The perspective of trust 143
Xiaobei Liang, Chuyang Xie & Li Tang
15. Factors influencing the satisfaction of chat commerce usage experience in Thailand: A Covid necessitated e-business platform 160
Eralp Gullep, Asis Unyapoth & Poonphon Suesaowaluk
16. Finding customer behavior insights for content creation in material and product sourcing using specialized topic analysis 177
Noptanit Chotisarn, Phanuphong Siriphongwatana, Phattranit Thanisuwiphat, Sarun Gulyanon & Winai Nadee
17. Healthcare gamification: Science mapping the body of literature 185
Franklin Jean Machado & Otávio Próspero Sanchez
18. Health-related misinformation sharing on social media in Thailand: A case study during the COVID-19 pandemic 202
Wijitra Kongkauroptom, Peter Ractham, Laddawan Kaewkitipong, Eric M.P. Chiu & Sirikorn Namlabut
19. How does COVID-19 disrupt traditional success models: The case of e-learning 212
Michel Plaisent, Asli Gül Öncel, Daniel Tomiuk, Younes Benslimane, Cataldo Zuccaro & Prosper Bernard
20. I-Fintech adoption readiness 226
Dil Nawaz Hakro, John R. Hamilton, Singwhat Tee & Michael Underdown
21. Impact of e-HRM system on employee performance 235
Theppithak Kaewkhamnuan & Siriluck Rotchanakitumnuai
22. Improving spam filtering in enterprise email systems with blockchain-based token incentive mechanism 247
Xiaoying Xu, Minghao Tian & Zhihong Li
23. Independent station: A new model of cross-border e-commerce 257
Yazhao Dong & Yitang Zeng
24. Influencing factors of resident satisfaction in smart community services: An empirical study in Chengdu 265
Rongxin Jin, Yifan Liu, Lichen Yang & Xiang Chang
25. Is online learning still necessary after the pandemic? A study of students' opinions towards factors affecting learning 280
Sawitree Boonpatcharanon, Pimmanee Rattanawicha, Janjao Mongkolnavin & Chaiyasut Jongtavornvitaya
26. Key factors of adopting energy management systems in building sector in Taiwan 289
Chihwei Chang & Wei-Hsi Hung
27. Measuring the modeling complexity of microservice choreography and orchestration: The case of e-commerce applications 299
Mahtab Haj Ali, Razibul Hasan & Morad Benyoucef

28.	Modeling IoT enablers for humanitarian supply chains coordination <i>Mohammad Reza Sadeghi Moghadam, Iman Ghasemian Sahebi, Behzad Masoomi, Mahdi Azzavi, Ali Anjomshoae, Ruth Banomyong & Peter Ractham</i>	315
29.	Performance evaluation on the implementation of Pre-established Medical Processes for nurse practitioners in the hospitals <i>Min-Chen Lu, Ju-Peng Chen, Yu-Hsuan Li, Chin-Yeh Lin & Wei-Min Huang</i>	323
30.	Research hotspots and trends of fresh e-commerce in China: A knowledge mapping analysis based on bibliometrics <i>Qiongwei Ye, Caiming Huang, Dan Ding, Qichen Liao & Yiu Ching Chan</i>	331
31.	Research on agricultural supply chain finance supporting sustainable poverty reduction under the background of digital technology <i>Qiming Zheng, Mingxuan Zheng & Yaqin Dou</i>	343
32.	Research on promotion mode of dual channel supply chain considering consumer channel preference <i>Junlin Chen & Wei Gao</i>	354
33.	Research on the application of smart supply chain finance in the financing of private scientific and technological enterprise in China <i>Yaqin Dou, Mingxuan Zheng, Yishen Wu & Shaobu Bai</i>	363
34.	Research on the impact of securities liquidity on momentum investment strategy returns <i>Juwen Yang & Yongzhong Yang</i>	373
35.	Research on the influence of art perception on consumers' purchase intention in online shopping environment <i>Qiaochu Ji & Yongzhong Yang</i>	384
36.	Research on the influencing factors of demand for elderly care services based on data of elderly care service information system <i>Fan Ke & Luoming Liang</i>	392
37.	Research on user participation behavior of mobile short video APPs: Taking Xiaohongshu as an example <i>Jiixin Liu & Yijun Liu</i>	406
38.	RFL-based customer segmentation using K-means algorithm <i>Atena Boubehreje, Neda Abdolvand & Omid Sojodishijani</i>	416
39.	Sales forecasting of stores in shopping malls: A study based on external data and transaction data <i>Qiongwei Ye, Qiang Yuan, Dan Ding, Qichen Liao & Yiu Ching Chan</i>	426
40.	Smart home on the rise? The role of trust and privacy in technology acceptance of smart home devices <i>Martin Roloff & Fabian Lang</i>	436
41.	Soft systems modelling of design artefacts for blockchain-enabled precision healthcare as a service <i>Arnob Zahid, Ravishankar Sharma, Stephen Wingreen & Anushia Inthiran</i>	451

42.	Sustainable competitive advantage in entrepreneurial software firms in Pakistan: Establishing a conceptual research framework <i>Syeda Arfa Ali, John R. Hamilton, Singwhat Tee & Michael Underdown</i>	468
43.	The effect of pandemic and website information on consumers' perceived satisfaction in the hotel industry: An exploratory study focusing on e-marketplace consumers in South Korea <i>Kwonneung Joo, Jooyoung Kim & Hangjung Zo</i>	483
44.	The impact of emotionally negative online reviews on consumer purchase intentions <i>Yilu Sun, Ying Zhao & Yao Ma</i>	493
45.	The impact of signal of project quality and creator's credibility on crowdfunding performance based on FsQCA method <i>Yuhong Luo, Nianjiao Peng, Xiaona Li & Yuanyue Feng</i>	506
46.	The influence of online Danmu on users' reward behavior: Based on the data of Douyu live broadcast <i>Jiixin Huang, Yewu Dang & Liang Zhou</i>	515
47.	The influence of product color displayed on online advertisements and consumer personality on purchase intention during the post pandemic: The moderating role of age and gender <i>Safae Ait Hamou-ou-Brahim, Soukaina Zaoui, Haiwei Zhou & Dechun Huang</i>	526
48.	The rising of livestream business model: Insights from the case study of TikTok in UK <i>Jianqin Zhao & Honglei Li</i>	535
49.	The role of remixing for innovation in online innovation communities <i>Seungyeop Baik, Sunyoung Choi, Suho Ahn & Hangjung Zo</i>	544
50.	The value of additional reviews in reputation systems: Evidence from a car review platform <i>Xiao Fan, Ao Sun & Xudong Liu</i>	552
51.	Understanding perceived shopping effectiveness with omnichannel: A MOA theory perspective <i>Thi-Hoa Pham</i>	560
52.	Understanding work behaviors in remote work environments during the COVID 19 pandemic: Transaction cost theory perspective <i>Xi Chen & Wei-Hsi Hung</i>	568
53.	Usability evaluation of a mobile health application by older adults in Thailand <i>Ganokporn Maphundoong, Laddawan Kaewkitipong & Eric M.P. Chiu</i>	576
54.	Using artificial intelligence to study the impact of jobseekers' Facebook profile pictures on recruiters' interview decision <i>Shu-Fen Ko, Eldon Y. Li & Ya-Ling Wu</i>	585
55.	Using text analytics to discover organizational congruences: A study of the Thai IT industry <i>Buraj Patrakosol</i>	593
56.	Would you mind your language, please? Consumer incivility on social media platforms <i>Maqsood H. Bhutto, Aijaz A. Shaikh & Heikki Karjaluoto</i>	604

PART 2: Work-in-Progress Papers

57. An empirical research on the influencing factors of consumers' intention to use "one-hour e-commerce": Taking JD Daojia as an example 613
Zeng Yitang, Du Guanghua & Tan Chunhui
58. An empirical study on factors affecting purchase intention of cross-border e-commerce consumer in post-pandemic era 620
Kun Tian, Yitang Zeng & Zhongming Nie
59. Buying behavior during online visits at two retail websites: Possible effects of COVID-19 627
Chatpong Tangmanee
60. Digital financial literacy as a business model: The case study of a fintech start-up 633
Ruilin Zhu, Smita Paul & Ivan Muck
61. Exploring achievement gamification on online medical quality based on machine learning and empirical analysis 637
Shuqing Chen, Xiaofei Zhang, Xitong Guo & Kee-Hung Lai
62. Fur Babies, governance, and ability: Finding meaning in survey response rates 643
Suzie Pont, Michael Underdown, John R. Hamilton, Singwhat Tee & Stephen J. Maxwell
63. Gerontechnology acceptance of smart homes: A systematic review and meta-analysis 647
Roberto Louis Forestal & Eldon Y. Li
64. Modelling the mitigation of the negative effects on human resource management 654
Suzie Pont, Michael Underdown, John R. Hamilton & Singwhat Tee
65. Preserving talent: Employee churn prediction in higher education 661
Jariya Limjeerajarat & Damrongsak Naparat
66. Promoting consumers' online brand attention: The study of spatiotemporal analysis in regional apples 668
Tingting Zhang & William Yu Chung Wang
67. Research on technical analysis of basketball match based on data mining 674
Ji Wen & Lv Tao
68. RFID and environmental sustainability: case of Weatherford firm in the oil and gas drilling industry 680
Rebecca Angeles
69. Social media marketing: A bibliometric study in digital marketing literatures 687
Karry Kailin Hsu & Wei-Hsi Hung
70. The impact of information systems vulnerability announcements on firms' market value 694
Xueming Niu, Weihua Li, Jinfeng Zhang, Xiong Zhang, Jianlong Chen & Haijie Xu

71.	The learning dimension of digital transformation: Transforming with learning patterns <i>Jan Aidemark</i>	701
72.	Transforming nested structures of flowchart into hierarchical coloured Petri Nets <i>Methawi Phokhai & Wiwat Vatanawood</i>	707
73.	Understanding donation intention in live-streaming from dedication and constraint perspectives <i>Shih-Wei Chou & Trieu Nguyen</i>	714
74.	Understanding the service gap between caregivers and recipients in the smart bed system <i>Eldon Y. Li, Wei-Hsi Hung, Yu-Wen Huang & Jia-Xiang Chang</i>	720
75.	Understanding users' trust transfer mechanism in food delivery APP <i>Trang Nguyen & Xuan Tai Mai</i>	725
76.	What drive the successes and adoption of cryptocurrencies? <i>Gerrard Li & Cheuk Hang Au</i>	732

"Share for bargaining?": A willingness model based on privacy computing theory

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ABSTRACT

The use of mobile coupons to share for bargaining has become an important marketing method for merchants in the field of e-commerce. However, there are still some shortcomings in the existing research on consumers' willingness to share mobile coupons. First of all, the use and sharing of mobile coupons are analyzed separately. Secondly, most of theories and models in this domain derive from the field of knowledge. Lastly, the influence of different platforms on consumers' willingness to share are not considered. Therefore, this paper explores the influencing factors of consumers' willingness to share mobile coupons in different platform scenarios from the perspective of privacy computing, and proposes six hypotheses to construct a structural equation model. Further analysis of 270 valid questionnaires obtained under five scenarios shows that users' perceived economic benefits and perceived social benefits have a significant positive impact on users' willingness to share for bargaining, users' perceived privacy risks have no significant impact on users' willingness to share for bargaining, and users' perceived social risks have a significant negative impact on users' willingness to share for bargaining. Low share for bargaining links will weaken the negative impact of perceived social risk on sharing willingness.

Keywords: Mobile coupons, sharing willingness, structural equation, privacy computing.

INTRODUCTION

"Share for bargaining" has now become an important means for many e-commerce platforms to promote and attract new products, solving the problems of inaccurate marketing and low coupon redemption rates that have been plaguing merchants (Liu et al., 2016). For example, Pinduoduo used "social e-commerce" as a gimmick in the early days, and carried out viral fission spread in WeChat's social ecology through "bargaining" to achieve low-cost and rapid promotion and marketing purposes. At present, "share for bargaining" is not only limited to shopping and other consumption scenarios, but also appears in new scenarios such as travel and entertainment. It has become an important means for businesses to reach new users, maintain old users and improve product sales. Therefore, it is of great practical significance and practical value to deeply explore the internal motivation and influencing factors of users' share for bargaining behavior, and provide targeted opinions and suggestions for merchants and service providers, so as to achieve efficient business expansion and development.

Mobile coupons are the main carrier of "sharing and bargaining" behavior. At present, scholars' research direction of mobile coupons has gradually paid attention to users' behaviors from the technical perspective, such as establishing a secure and stable coupon distribution system. In the latter research perspective, researchers tend to focus on the use intention of mobile coupons, such as continuous use intention, adoption intention, etc., and pay less attention to user recommended mobile behavior (that is, mobile coupon sharing behavior) (Liu, 2019). From the perspective of theoretical basis, there are already many mature theories in the field of knowledge and information at present, and the research in the specific scenario of "mobile coupons" is mostly based on it, such as the use of social capital theory, motivation theory, etc., but there is no theoretical model specifically for the mobile coupon scenario. In terms of the influencing factors discussed, scholars mostly based on the existing models and discussed the influencing factors of mobile coupon sharing from the perspective of consumer behavior or psychological perception, or from the perspective of motivation and attitude. The analysis of the factors of the platform or use scenario is still limited, and the attributes and characteristics of the commodity itself are less concerned by scholars.

Therefore, this paper is based on the previous research, and considering that the use of mobile coupons for "share for bargaining" involves the privacy of users, so from a new perspective - the perspective of privacy computing, a structural equation model is constructed to explore the motivation, psychology and other factors of users, as well as the impact of platform factors on users' willingness to share mobile coupons for bargaining. Therefore, there are two main theoretical innovations in this paper: on the one hand, it discusses the impact of user privacy on users' sharing willingness from the perspective of privacy computing, and on the other hand, it discusses the impact of platform factors on users' sharing willingness.

LITERATURE REVIEW

Related Theory

The research on the willingness to share and adopt in the specific scenario of “mobile consumer coupons” is mostly based on the technology acceptance model or the integrated technology model (Wang et al., 2015), but in related fields, such as the field of knowledge and information sharing and adoption, there are relatively mature theoretical models, such as social capital theory, social cognition theory, motivation theory, etc. (Su et al., 2011). This part will introduce three commonly used theories or models in the field of user sharing behavior research—technology acceptance model, motivation theory, motivation adoption model, and social capital theory. Finally, this part introduces the privacy computing theory adopted in this paper.

The Technology Acceptance Model (TAM) is the most commonly used model in the field of mobile coupon user use and sharing behavior research, and existing research is mostly based on it or combined with other related theories (Wang et al., 2015). The technology acceptance model is a theoretical model proposed by Davis et al. in the late 1980s to apply rational behavior in social psychology to management information systems. It emphasizes the influence of internal variables such as behavioral intentions, subjective attitudes and internal beliefs, as well as other related external factors, and is mainly used to explain people’s acceptance of new information technology (Gao, 2010). In the technology acceptance model, there are two important factors: perceived ease of use and perceived usefulness. The former mainly refers to the degree of effort that users believe to use a new technology, while the latter refers to the degree to which users subjectively believe that the new technology can improve work and life efficiency. The technology acceptance model believes that the user’s perceived ease of use is a user’s process expectation. The higher the perceived ease of use, the corresponding outcome expectation, the greater the perceived usefulness. Both of them further jointly affect users’ attitudes towards use. However, some scholars pointed out that the use of TAM model as the basis to explore user adoption and sharing behaviors in mobile scenarios is flawed to a certain extent: in the mobile scenario, the user’s behavior is an autonomous consumption behavior, which is contrary to the compulsive behavior in TAM’s main work-study application scenarios (Kim et al., 2007). Therefore, existing scholars have also carried out research from new perspectives when studying behaviors such as “user sharing” and “user adoption” in mobile scenarios (Liu et al., 2016).

Motivation theory is widely used in the study of human behavior (Zhao et al., 2016). The main point of motivation theory is that motivation plays a decisive role in the starting point and continuous process of individual activities, and it is also an important driving force for individual activities toward a specific goal (Liu et al., 2016). Davis et al. combined perceived ease of use with motivation theory to construct a motivational adoption model (Davis et al., 1992). This model is mainly used in the field of users’ adoption of new technologies, and related research has also confirmed that the theory can effectively predict users’ behavior of using new information technology in a non-work environment (Lin et al., 2011), so it is also widely used in the research of users’ knowledge and information sharing. In the field of user sharing behaviors such as mobile coupons, the model needs to be revised to some extent. For example, Fang Liu and others believe that the operation of mobile coupons is relatively simple, and they do not pay too much attention to “perceived usefulness”, but discuss personal characteristics from the perspective of consumer consumption, such as cognition, belief, etc. (Liu et al., 2016). Some scholars also believe that the sharing of mobile coupons is a pro-social behavior, in which altruistic motivation is added (Carlo et al., 2005). Tang et al. explored the influencing factors of users sharing mobile coupons from the perspective of motivation, such as perceived value, economic reward, reciprocity exchange, and social motivation (Tang et al., 2016). Zhao et al. combined motivation theory with social capital theory to study the impact of trust, perceived similarity and social relations on mobile coupon sharing (Zhao et al., 2016).

The theory of social capital is widely used in the research of users’ sharing behavior, which refers to the sum of actual and potential resources contained in the relationship network owned by individuals or social units (Chiu et al., 2007). There are three main dimensions of social capital: structural capital, relational capital and cognitive capital (Nahapiet et al., 1998). Some scholars have pointed out that three different dimensions of social capital will affect members’ information or knowledge sharing behavior (Chow et al., 2008), and the motivation of “user sharing” (here refers to knowledge sharing) can be explained by social connection (structural social capital), emotional trust (relational social capital) and the same goal (cognitive social capital). Chiu et al. built a model based on social capital theory and social cognition theory to explore the behavioral motivation behind people’s sharing knowledge in virtual communities (Chiu et al., 2007); Zhao et al. collected data from well-known business communities in China and confirmed the three different dimensions of social capital will affect people’s knowledge sharing behavior (Ling et al., 2012).

In addition, some scholars have explored the influencing factors of user sharing behavior from multiple perspectives based on theories such as self-determination, adjustment orientation theory and valence theory, immersion theory and selective attention theory, information behavior theory and consumer behavior theory. For example, Jeng et al. explored the influence of personal characteristics on individual behavior and motivation in the context of Internet and online travel (Amiel et al., 2004; Jeng et al., 2008), while Yuejiao Fan explored the influence of individualistic tendencies on sharing willingness in the field of coupon sharing (Fan et al., 2020). But in general, the existing theory has not yet made adequate and targeted adjustments to the field of “mobile coupons”.

It can be seen that the above related theories have carried out research on user sharing behavior from the perspectives of users’ perception of the platform, users’ internal and external motivations, and the community environment where users live, but

failed to take into account that users will also face the risk of personal privacy disclosure in the process of sharing. And this issue has been paid attention to in 2001, but few scholars have explored its impact on users' willingness to share from the perspective of user privacy. Xue Ke and other scholars proposed that due to the culture of advocating collectivism, there is a more intuitive and obvious privacy paradox phenomenon in my country's social media (Xue et al., 2016). Scholars have expounded from different perspectives. Some scholars have proposed that due to the bounded rationality of human beings, there is a risk of ignoring privacy disclosure. Some scholars have explained from the perspective of social exchange theory. When people are informed about the process of collecting privacy open and far, people will tend to believe and provide personal information. Around the phenomenon of "privacy paradox", scholars have gradually developed the theory of privacy computing based on the theory of maximum effect and social exchange. The theory of privacy computing believes that individuals will take corresponding actions only after rational calculation. In the process of choosing whether to disclose personal factors, users will weigh the perceived benefits and perceived risks. Only when the former is greater than the latter, the user will choose to make private disclosures (Lee, 2011). Therefore, the calculation of perceived benefits and perceived risks is the core content of privacy computing.

Factors Influencing Willingness to Share

Regarding the research on the influencing factors of mobile coupon sharing, scholars have not reached a unified conclusion, and the factors discussed are not the same. Most of the existing scholars' research ideas are based on research models or theories in related fields to explore the impact of corresponding influencing factors on consumers' sharing behavior in the "mobile coupon" scenario. Fang Liu et al. analyzed the motivation and behavior of users to share mobile coupons from the theoretical framework of "experience perception-experience evaluation-behavioral intention" (Liu, 2019). Fang Liu believes that a good experience for consumers is conducive to positive word-of-mouth communication, and experience value is an important indicator to measure the gains and losses of consumers in the process of experiencing products, reflecting the overall perception of consumers, and customer satisfaction is always an important issues, which are the key to promoting repeat purchases, retaining and enhancing customer loyalty. It also further considers external factors, such as business and system factors. Among them, the experience value is composed of hedonic value and practical value, the hedonic value is reflected by the streaming experience, the practical value is reflected by the perceived coupon value. From the perspective of business, it is mainly measured by users' perceived equality, coupon factor mainly considers perceived economic benefits, and system factor mainly considers perceived system quality.

Yuejiao Fan et al. draw on the research of other scholars, and from the perspective of individualistic tendencies, they propose that individualistic tendencies can positively affect users' mobile coupons. Based on the assumption of willingness to share, and from the perspective of internal and external motivation, a new model is constructed with perceived social value and perceived economic value as mediating variables (Fan et al., 2020). In the model, Yuejiao Fan believes that perceived social value is interpreted as sharing mobile coupons to improve self-worth and image, while perceived economic value is material rewards such as red packets and points obtained directly or indirectly through sharing mobile coupons, both of which will positively affect the willingness to share mobile coupons. It also considers the user's perceived risk in the process of sharing mobile coupons, and uses it as a mediating variable to adjust the influence of individualism on the willingness to share mobile coupons.

Based on social capital and motivation theory, Zhao et al. discussed the influencing factors and mechanisms of mobile coupon sharing behavior, and constructed a new model. In the model, Zhao takes the three kinds of social capital mentioned in the social capital theory as antecedent variables, and constructs three constructs of "social tie", "trust" and "perceived similarity". Zhao believes that in the process of sharing mobile coupons, if the recipients of mobile coupons obtain a certain degree of economic benefits, the sharers will have a high sense of self-worth, and there will also be some risks in the process of sharing mobile coupons. It helps the sharer to consolidate and maintain the relationship in the community. Therefore, the author believes that both will positively affect the sharing willingness of mobile coupons, and form two constructs of "sense of self-worth" and "socializing" thought as a mediating variable to influence the final mobile coupon sharing willingness.

In addition, Zhao believes that mobile coupons are not only information sharing, but also have certain economic value (Zhao et al., 2016), so they focus on the perceived value of customers in the process of sharing mobile coupons. Mingyuan Wang et al. focused on the influence of users' herd behavior on the willingness to share mobile coupons (Wang et al., 2015). Chiu et al. considered the influence of community attributes on sharing intention (Chiu et al., 2007), Fang Liu and Xuefeng Zhao considered the influence of perceived entertainment and other factors from the perspective of internal and external motivation (Liu et al., 2016). In general, although scholars focus on different perspectives, the perspectives are basically similar. This paper summarizes the influencing factors of mobile coupon sharing willingness and obtains Table 1.

Table 1: Influencing factors of mobile coupon sharing willingness

Research Perspective	Influencing Factors
System Angle	Perceived ease of use, perceived usefulness, etc.
Individual User	Personal innovation, individualistic tendencies, personal characteristics, etc.
Perceived Value	Perceived economic value, perceived social value, perceived self-image, etc.
Perceived Cost	Perceived risk, perceived effort, etc.
Community	Social connection, trust, identity, common goals, etc.

other	Conformity, perceived entertainment, perceived equality, altruism, etc.
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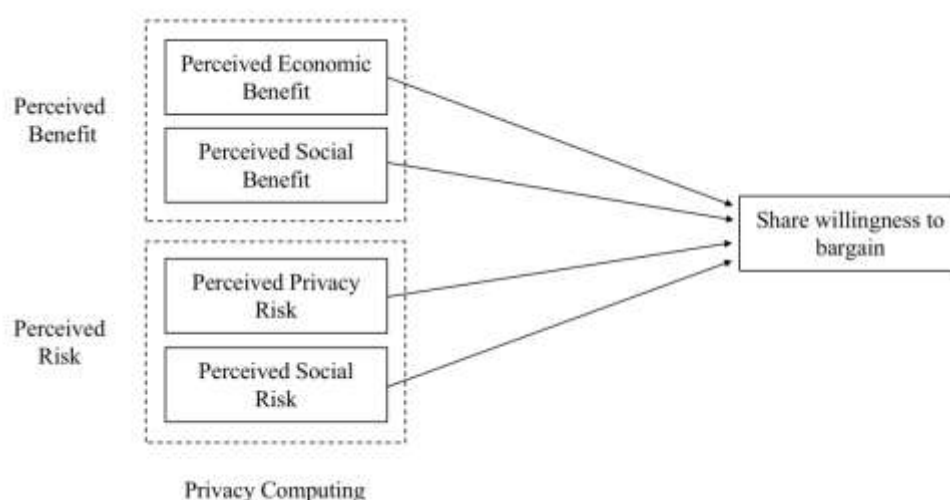
Source: This study.

MODELS AND ASSUMPTIONS

Based on the literature review section above, for the specific research question of “share for bargaining”. We believe that “share for bargaining” is a kind of sharing behavior, which can be further studied based on relevant research and theories on sharing behavior; similarly, different from traditional sharing behaviors, “share for bargaining” will directly disclose the e-commerce platform used by the user is even the product to be purchased, so it is also a behavior of privacy disclosure; secondly, users who “share for bargaining” sometimes not only get discounts for themselves, but also hope that the shared objects can get corresponding discounts, with certain social attributes.

This study selects the relevant theories of privacy computing as the basic theoretical framework. The phenomenon of “privacy paradox” has attracted the attention of many scholars. Users’ privacy behaviors are not always particularly rational. Under certain circumstances, users will ignore or reduce their privacy concerns and conduct privacy disclosure behaviors. Similarly, many scholars have conducted in-depth research on the process of users’ own privacy-related decisions, and found that users always make trade-offs between benefit acquisition and privacy disclosure. Before making decision-making behaviors, users often choose to maximize their own benefits (Culnan et al., 2003). In other words, when users feel that the gain is greater than the effort, they tend to choose to conduct privacy disclosure (Dinev et al., 2006).

After reading the previous literature, we finally selected four core variables of perceived economic benefit, perceived social benefit, perceived privacy risk, and perceived social risk as the pre-variables for sharing willingness to bargain. We believe that in this research question, under the framework of privacy computing, the variables are divided into two categories: perceived benefit and perceived risk. Perceived benefits are the results that are beneficial to users, such as economic benefits, social integration, and specific services of merchants, after users conduct privacy disclosure. Many empirical studies have proved that economic compensation (Hann et al., 2007), social participation and social identity (Yin et al., 2004) can all enhance users’ intention to conduct privacy disclosure. Perceived risk refers to the degree of loss that users think they will bring to themselves after disclosing their privacy (Malhotra et al., 2004). The above four variables perceived by users can comprehensively integrate relevant theories, covering key attributes such as sharing behaviors, privacy disclosure behaviors, and social attributes related to “share for bargaining”. The main model proposed is as follows:



Source: This study.

Figure 1: Research model

Perceived Benefit and Willingness to share for bargaining

In the model of this study, the perceived benefit part contains two variables, namely perceived economic benefit and perceived social benefit. Perceived economic benefits refer to the economic benefits and returns that users think the behavior may bring to themselves when they share for bargaining. Perceived social benefits refer to the extent that users use the corresponding social media platform to share when share for bargaining, and think that this behavior can bring them a sense of social belonging and better interpersonal relationships.

We believe that if share for bargaining can bring certain benefits to users and help users purchase goods or services at a lower price, then users may be more willing to share for bargaining; If users can get interaction and maintenance of their own interpersonal relationship through share for bargaining behavior, or can bring corresponding benefits to others, such two-way interaction can improve the interpersonal relationship between users and the shared person or the shared group, so the user may be more willing to share for bargaining. Based on this, we propose assumptions H1 and H2.

H1: Users' perceived economic benefits positively affect users' willingness to share for bargaining

H2: Users' perceived social benefits positively affect users' willingness to share for bargaining

Perceived Risk and Willingness to share for bargaining

In the model of this study, the perceived risk part contains two variables, namely perceived privacy risk and perceived social risk. Perceived privacy risk refers to the loss that may be caused by such disclosure behavior when users share for bargaining, including the fact that personal privacy information is known and abused by others, which is the expectation of users for the bad results that can be caused by this behavior. The perceived social risk refers to the fact that users' share for bargaining behavior may have an impact on the person being shared. For example, sharing a bargaining link may disturb the other party, or cause others to be disgusted, change others' views of themselves, and thus affect the social relationship between sharers and sharers. Based on this, we propose assumptions H3 and H4.

H3: Users' perceived privacy risks positively affect users' willingness to share for bargaining

H4: Users' perceived social risks positively affect users' willingness to share for bargaining

In addition to the above assumptions, based on the above model, this study designs scenario experiments to study the impact of platform factors on the paths in the model. The platform factors involved in the scenario questionnaire include the type of platform commodity purchase, sharing, value and privacy disclosure.

According to the research and analysis of the current mainstream Internet e-commerce platforms in China, this study divides them into four categories:

Table 2: Classification of mainstream e-commerce platforms in China

Category	Representative Platform
Shopping Platform	Taobao, JD, Suning, Vipshop, Pinduoduo and e-commerce live broadcast platforms, etc.
Daily Travel Platform	Didi, Hello Bike, etc.
Long Distance Tourism Platform	Ctrip, Qunar, Tuniu Travel, etc.
Takeaway Platform	Meituan, Ele.me, etc.

Source: This study.

According to the above table, five scenarios are set, under which e-commerce platforms share some attributes of bargaining:

Table 3: Factor attributes of e-commerce platform

Scenario ID	Category	Purchase Type	Shareability	Value	Privacy Disclosure
1	Shopping Platform	Commodity	High	Low	Yes
2	Shopping Platform	Commodity	Low	High	Yes
3	Daily Travel Platform	Service	High	Low	No
4	Long Distance Tourism Platform	Service	Low	High	Yes
5	Takeaway Platform	Commodity	High	Low	No

Source: This study.

Sharing in the platform factor refers to the possibility that the shared users also buy or use the products that a user shares bargaining. Value refers to the price level of an item purchased under that category. Privacy disclosure or not means that when the shopping platform and the long distance travel platform share for bargaining, the platforms will directly display the specific details of the goods or services that the users will buy on the link where the user shares bargaining. It will be able to know the specific information of the goods and services that the sharer is about to purchase, such as the specific links of the goods purchased on Taobao, and the similar sharing links on Ctrip such as "I'm buying a ticket from Beijing to Shanghai". The sharing links of the daily travel platform and the takeaway platform do not disclose the specific purchase details of the user, but only share the brand link of the platform.

Based on the specific research questions of this study, sharing and privacy disclosure are selected as the platform factors for the key research. The level of sharing and value are opposite, so only sharing is selected as the key research object. Based on the experimental scenario set up in this study, for the platform factor of sharing, when users share a bargain, when the shared link may be useful to the shared person, the shared person will also get a discount when using the e-commerce platform. For example, after the sharing bargain chain of Didi is clicked, the person being shared will get the corresponding coupon, and the next time they use the platform, they can get the corresponding discount. In this scenario, the share for bargaining behavior is not only a sharing behavior for the benefit of individuals, but also for the benefit of the person being shared. The sharer may reduce the corresponding psychological burden and perceived social risk due to the benefit of the share. Regarding the platform factor of privacy disclosure or not, we believe that when more information is disclosed in the shared link, the risk of privacy leakage perceived by users will be higher. For example, the sharing link of Taobao will directly display the goods that

the sharer is buying, which may have greater privacy concerns for the sharer. Based on this, we propose assumptions H5 and H6.

H5: The share for bargaining link of low shareability will weaken the negative impact of perceived social risk on sharing willingness

H6: The share for bargaining link of privacy disclosure will enhance the negative impact of perceived privacy risks on sharing willingness

DATA COLLECTION AND STATISTICAL ANALYSIS

Questionnaire Design and Data Collection

According to the research hypothesis, this study sets 3-4 items for each of the 5 variables to be measured, and each scale adopts a 7-point Likert scale (1 means strongly disagree, 7 means strongly agree). In the independent variable part: First, the Chinese version of the scale revised by scholars such as Bock (Bock et al., 2005), Im and Ha (Im et al., 2015), and Choi S (Choi et al., 2008) et al. was used to measure perceived economic benefits, with a total of 3 items. Secondly, the Chinese version of the scale revised by Lee and Ma (Lee et al., 2012) is used for perceived social benefits, and the scale has 3 items in total; in addition, the perceived privacy risk adopts the Chinese version of the scale revised by Im and Ha (Im et al., 2015), Malhotra (Malhotra et al., 2004) et al. with a total of 4 items. Finally, the perceived social risk was measured using the Chinese version of the scale revised by Lee (Lee, 2011) et al. with a total of 4 items. In the dependent variable part, the willingness to share adopts the Chinese version of the scale revised by Bock (Bock et al., 2005), Lee and Ma (Lee et al., 2012), Chai (Chai et al., 2011) et al. with a total of 3 items on the scale. The measurement items of the scale are shown in the following figure:

Table 4: Measurement items of the scale

Variable	Measurement Item
Perceived Economic Benefit	1. In this scenario, I am willing to share if I can get a cash reward by sharing the bargain 2. In this scenario, I am willing to share if I can get a coupon by sharing the bargain 3. In this scenario, share for bargaining can save me money
Perceived Social Benefit	1. In this scenario, I can feel a sense of belonging to the social media by share for bargaining on social media 2. In this scenario, I can interact with others by share for bargaining on social media 3. In this scenario, I can keep in touch with others by sharing bargains on social media
Perceived Privacy Risks	1. In this scenario, I need to display my product or platform information when share for bargaining, which may make me feel insecure 2. In this scenario, I need to display my product or platform information when share for bargaining, which may bring some unexpected troubles 3. In this scenario, I need to display my product or platform information when share for bargaining, which may bring risks to me 4. In this scenario, I need to display my product or platform information when share for bargaining, which may cause me to suffer unnecessary losses
Perceived Social Risk	1. In this scenario, I am worried that the link generated by share for bargaining may be regarded as an advertisement and disturb the others 2. In this scenario, I am worried that frequent share for bargaining links will arouse disgust from others 3. In this scenario, I am worried that the bargaining links I share will change other people's perceptions of me because the price is too low. 4. In this scenario, I am worried that the bargaining link I share will reduce my image in front of others due to the characteristics of the content
willingness to share for bargaining	1. In this scenario, I intend to share the bargain 2. In this scenario, I expect to receive a link to share the bargain contributed by other friends 3. In this scenario, I plan to share for bargaining frequently if allowed

Source: This study.

In this study, the method of designing scenarios was used to conduct the questionnaire survey. The following five research scenarios were set up in each questionnaire. After the participants were asked to understand the scenarios, they were asked to fill in the questionnaire. The scenario design is as follows:

Scenario 1

One day, you choose a favorite product (it can be a lipstick, a pair of sneakers, an iPhone 14, etc.) on e-commerce shopping platforms such as Taobao/JD/Suning/Vipshop/Pinduoduo. Such products are often overpriced, and when you decide to buy this product, you probably think that this product will give you a good experience. Before you are ready to pay, you notice that there is an icon of "Share Coupon" on the interface, and click it to get a prompt "Share with 3 friends, this product will get 5% off". At this time, if you share this product link to social media platforms such as friends or Moments, after accumulative 3 clicks, both you and your friends can get the discount qualification of this product.

Scenario 2

One day, you choose to buy a daily product (it can be snacks, toothpaste, toothbrush, school supplies, etc.) on an e-commerce shopping platform such as Taobao/JD. Such products are often more practical and have a larger user base. Before you are ready to pay, you notice that there is an icon of “Share Coupon” on the interface, and click it to get a prompt “Share with 3 friends, this product will get 5% off”. At this time, if you share this product link to social media platforms such as friends or Moments, after accumulative 3 clicks, both you and your friends can get the discount qualification of this product.

Scenario 3

One day, when you complete an order in daily transportation apps such as Didi and Hello Bike. After paying, you notice that there is an icon of “Share Courtesy” on the interface, and click it to get a prompt “Share to 3 friends, get 5% off this order”. At this time, if you share the referral link generated by the platform to social media platforms such as friends or Moments, after accumulatively 3 clicks, both you and your friends can get the discount qualification of the platform. For example, when you paid 100 yuan for a ride on Didi Express, and you choose to do this sharing behavior, you will get 5 yuan back to the payment channel after completing the request. And the friend who clicks will also get a 5% off coupon (which can be used in combination with other discounts)

Scenario 4

One day, when you decide to buy a travel/train ticket/hotel accommodation product on Qunar/Ctrip and other platforms. When you are ready to pay, you notice that there is an icon of “Share Courtesy” on the interface, and click it to get a prompt “Share with 3 friends and enjoy 5% off this order”. At this time, if you share the recommended link generated by the platform (which will display some travel information, such as travel to the city, etc.) to social media platforms such as friends or Moments, after accumulative 3 clicks, both you and your friends will obtain the preferential qualification of the platform.

Scenario 5

One day, when you complete an order on a food delivery platform such as Ele.me/Meituan. After paying, you notice that there is an icon of “Share Courtesy” on the interface, and click it to get a prompt “Share to 3 friends, get 5% off this order”. At this time, if you share the recommended link generated by the platform (which will display some itinerary information, such as going to the city, etc.) to social media platforms such as friends or Moments, after accumulating 3 clicks, the discount amount will be returned to the payment channel, and friends can obtain a 5% discount coupon qualification of the platform (can be used in combination with other discounts).

We adopt the method of convenience sampling and use the professional questionnaire website “Questionnaire Star” to set up the questionnaire questions and distribute the questionnaires. The link invites the subjects to answer through WeChat group, QQ group, private chat, etc. in the form of link and QR code. A total of 307 questionnaires were collected in this survey, and 270 valid questionnaires were obtained, with an effective rate of 87.95%, by excluding those with short response time (less than 60 seconds) or those with random test results (such as the same number of consecutive large films).

Descriptive Statistical Analysis

Table 5: Descriptive statistics

Descriptive Variable	Content	Number of Samples	Proportion
Gender	Male	90	33.3%
	Female	180	66.7%
Age	Below 18	2	0.7%
	18-24	250	92.6%
	25-30	16	5.9%
	Over 30	2	0.7%
Education	High school and below	3	1.1%
	Junior college/Undergraduate	121	44.8%
	Master and above	146	54.1%
Whether the platform is used in the scenario	Yes	218	80.7%
	No	52	19.3%
Times of sharing the bargain	0 times	76	28.1%
	1-5 times	140	51.9%
	5-10 times	30	11.1%
	More than 10 times	24	8.9%

Source: This study.

It can be seen from the table that among the 270 valid questionnaires, there were more female samples, accounting for 66.7%. The subjects were mainly college students, and most of the subjects had used the platforms mentioned in the scenario and had shared bargaining behaviors, which was in line with the degree of dissemination of the link to share for bargaining.

DATA ANALYSIS

Reliability Analysis

Table 6: Reliability analysis table

Variable	Cronbach's α	CR
Perceived Economic Benefit	0.904	0.940
Perceived Social Benefit	0.904	0.940
Perceived Privacy Risks	0.897	0.922
Perceived Social Risk	0.880	0.925
Willingness to Share the bargain	0.932	0.871

Source: This study.

The results of reliability analysis of the five variables involved in this study are shown in the table above. It can be seen from the table that the Cronbach's α values are all far above 0.7, indicating that the selected scales have good internal consistency, and the combined reliability CR is far above 0.7, indicating that the factors have good reliability and good factor structure. In conclusion, the scale of this study has high reliability.

Validity Analysis

Convergent validity analysis

Table 7: Convergent validity analysis table

Variable	Factor Loadings	AVE
Economic Benefit	0.893 0.917 0.882	0.805
Social Benefit	0.894 0.933 0.921	0.839
Privacy Risk	0.746 0.598 0.951 0.846	0.634
Social Risk	0.926 0.929 0.777 0.815	0.747
Willingness to Share	0.923 0.906 0.917	0.838

Source: This study.

Convergent validity was measured by factor loading values and mean extracted variance (AVE). According to the above table, the factor loading value of each item on the corresponding latent variable of the scale of this study is greater than 0.5, and the AVE of each variable is greater than 0.5, indicating that the model has good convergent validity.

Discriminant validity analysis

Table 8: Discriminant validity analysis table

Variable	Willingness to Share	Social Benefit	Social Risk	Economic Benefit	Privacy Risk
Willingness to Share	0.916				
Social Benefit	0.63	0.916			
Social Risk	-0.137	-0.064	0.864		
Economic Benefit	0.662	0.557	0.013	0.897	
Privacy Risk	0.109	0.131	0.438	0.083	0.796

Source: This study.

According to the results in the above table, the square root of the AVE of each variable is greater than the correlation coefficient, indicating that the model has good discriminant validity.

Hypothesis Test Results

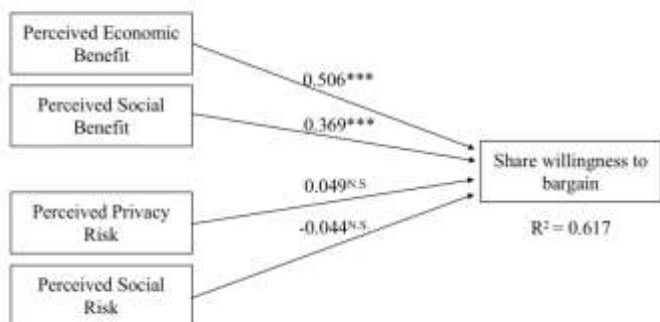
Table 9: Hypothesis test results table

Path	Normalized path coefficient	Value of T	Value of P	Test Result
Social Benefit -> Willingness to Share	0.35	5.606	***	Support
Social Risk -> Willingness to Share	-0.162	2.508	**	Support
Economic Benefit -> Willingness to Share	0.461	7.621	***	Support
Privacy Risk -> Willingness to Share	0.096	1.118	0.264	Not Support

Source: This study.

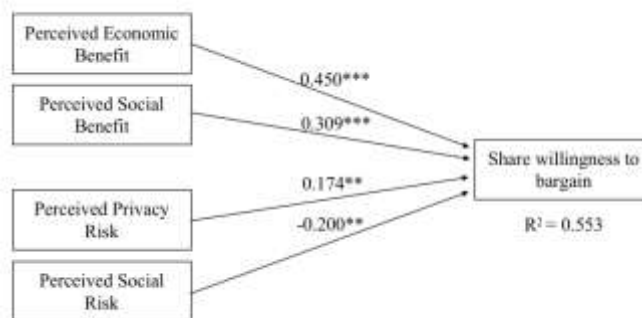
Note: *** mean $P < 0.001$

Assumptions H5 and H6 are tested with data sets under four scenarios: high sharing, low sharing, privacy disclosure and privacy non-disclosure. The model operation results are shown in the figure below.



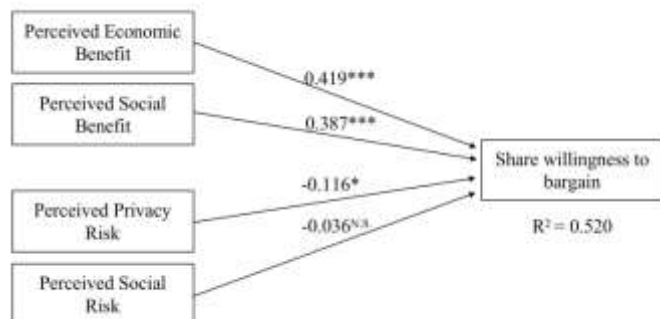
Source: This study.

Figure 2: Scenario Results (High Shareability)



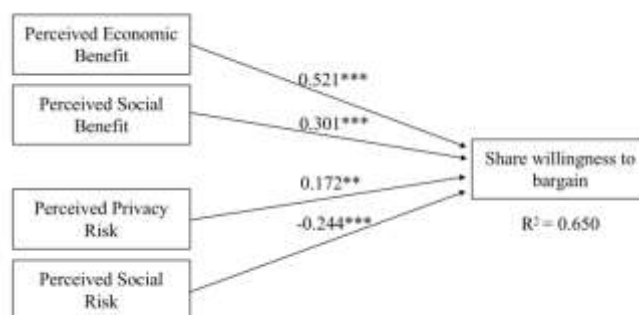
Source: This study.

Figure 3: Scenario Results (Low Shareability)



study.

Figure 4: Scenario Results (Privacy Disclosure)



Source: This study.

Source: This

Figure 5: Scenario Results (Privacy non-disclosure)

DISCUSSION AND INSPIRATION

Results Discussion

Based on the above research data, this study mainly draws the following conclusions:

First, in the process of share for bargaining, users' perceived economic benefits and perceived social benefits both significantly and positively affect users' willingness to share for bargaining. From the operating results, although both significantly affect users' willingness to share for bargaining, perceived economic benefits have a stronger impact on users' willingness to share for bargaining prices. This is consistent with our research background. The first purpose of most users' share for bargaining is to obtain corresponding economic benefits.

Second, in the process of share for bargaining, the impact of users' perceived privacy risk on the willingness to share for bargaining is not significant. This may be because in the share for bargaining, the privacy risk is essentially potential, and risks do not necessarily cause real loss of benefits for users, but the benefits obtained are immediately available. Once users choose to share for bargaining, they default to a certain extent that they are willing to sacrifice part of their privacy in exchange for part of their benefits, which may be the reason why this path is not significant.

Third, in the process of share for bargaining, users' perceived social risks significantly negatively affect users' willingness to share, which is consistent with our expectations. Users have many social worries and concerns when share for bargaining, which may be considered as advertisements to disturb the other, cause others' aversion, or reduce their image in front of others. In fact, this risk will occur immediately, when the sharer sees the link to share the bargain, this kind of social risk from the perspective of the sharer may occur instantly.

Fourth, in the process of share for bargaining, the share for bargaining links with low shareability will weaken the negative impact of perceived social risks on the willingness to share. Commodities with low shareability often correspond to commodities with higher prices. Users are share for bargaining so that the commodity is displayed to the shared person. This commodity may be a commodity that can show their own taste or a higher standard of living, such as a fashionable mobile phone, a link to a trip abroad. At this point, sharing the bargaining link may become a way to show your life, and users are relatively less concerned about the views and evaluations of the people being shared. For Hypothesis H6, the negative impact of perceived privacy risk on sharing willingness is not confirmed because the path itself is not significant.

Theoretical Inspiration

For the specific research problem of "share for bargaining". We believe that "share for bargaining" is a kind of sharing behavior, which can be further studied based on the relevant research and theories on sharing behavior; similarly, different from traditional sharing behaviors, "share for bargaining" is also a privacy disclosure behavior because it will directly disclose the e-commerce platform users use or even the goods they will buy; secondly, users of "share for bargaining" sometimes not only get discounts for themselves, but also hope that the shared objects can get corresponding discounts, with certain social attributes.

Share for bargaining itself is a new kind of thing, which has not received extensive attention from scholars for the time being. From the perspective of privacy computing, this study conducted situational experiments to explore the impact of dependent variables on sharing willingness. It is worth mentioning that this study considers the moderating effect of platform factors such as sharing, privacy disclosure and so on in the model, which provides a new idea for subsequent research.

Practical Inspiration

At present, e-commerce companies have generally adopted measures to encourage share for bargaining in order to enhance users' willingness to purchase, but they do not pay much attention to platform factors. Based on the perspective of privacy computing, this study proves that platform factors, as regulatory variables, can have a significant impact on users' willingness to share for bargaining, and further explores the construction of an antecedent variable system for users to share for bargaining, thereby guiding e-commerce companies' mobile coupon settings and marketing strategies provide feasible incentives for improving consumers' willingness to purchase.

First of all, at the level of purchase objects, we should fully consider the impact of its type; e-commerce companies can obtain the characteristics and laws of users' willingness to share for two different types of purchase objects of goods or services by analyzing users' existing bargaining behaviors. Secondly, at the level of sharing, it can be further divided into two situations: high sharing and low sharing; e-commerce companies can analyze the existing share for bargaining behavior of users to find out the characteristics and laws of users' willingness to share with different levels of sharing. Furthermore, in terms of value, it can be further divided into two cases: high value and low value; e-commerce companies can obtain the characteristics and laws of users' willingness to share for different value levels of purchase objects by analyzing users' existing bargaining behaviors. Finally, at the level of privacy disclosure, it can be further divided into two situations: privacy announcement and unpublished; e-commerce companies can analyze the existing share for bargaining behavior of users and draw the characteristics and laws of users' willingness to share with the purchase objects with different privacy disclosure status.

Research Limitations

Restricted by subjective and objective conditions, this paper still has the following limitations: First, when making research assumptions, this paper does not fully consider the possible influence and interference of various factors, which leads to the failure of some contents of the original research hypothesis model, and there is a certain deviation between the research results and research assumptions; in the future research process, it can be improved by supplementing research methods and methods, and analyzing the interaction between various factors. Secondly, the sampling method adopted in this paper is nearby sampling, and the sample size is also small, resulting in insufficient representativeness and extensiveness of the sample, and the test of the adjustment effect has not been verified; in the future research process, it can be improved by improving the sampling method and expanding the sample size and other ways. Finally, it is verified whether the research conclusions of this paper can produce expected results in production practice. In the future research process, it can be further explored on the basis of sharing the construction of the pre-bargaining dependent variable system.

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A mediation–moderation framework of consumers’ intention to participate in crowdfunding

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ABSTRACT

The purpose of this paper is to examine the role of perceived risk and shopping frequency as a mediator and a moderator in supporting a reward-based crowdfunding (CF) project by potential backers. A research framework is developed based on consumer decision-making styles and literature studies. A total of 218 valid responses are collected from offline shoppers through an online questionnaire to examine their perceptions and motivation to participate in a CF project on Indiegogo, one of the largest reward-based CF platforms. Descriptive statistics and Hayes’ PROCESS macro are used to analyze data. The results reveal five decision-making styles of Thai offline shoppers. When combining these styles, they significantly directly increase the tentative of offline shoppers to support a CF project, but indirectly decrease their backing intention through perceived risk. Past behavior in terms of respondents’ offline shopping behavior insignificantly moderate the relationships between consumer style inventory (CSI) and perceived risk, perceived risk and intention, and CSI and intention, but significantly help to lower their perceived risk. The results guide project owners in reward-based CF platforms in drawing attention from future backers, expanding their market, and creating marketing strategies for potential consumers with different decision-making styles. This work is one of the first papers that explores offline shoppers as potential backers, examines the impact of consumer decision-making styles, and analyze mediation and moderation models in the context of a reward-based CF platform.

Keywords: consumer styles inventory, decision-making styles, perceived risk, shopping frequency, intention, reward-based crowdfunding, offline shoppers.

INTRODUCTION

Crowdfunding (CF), originated from crowdsourcing, is an online open call for financial resources either in the form of donation or in exchange for a reward and/ or voting rights from a large number of individuals to support initiatives (projects) from other people or organizations (Bi, Liu, & Usman, 2017; Thies, Wessel, & Benlian, 2014). It is not constrained by geography and has become a valuable alternative source of funds for startups and small and medium enterprises (SMEs) to run their business activities. Crowdfunding provides economic benefits for ignored issues or business ideas by fostering social engagement (Bi et al., 2017; M. J. Kim, Bonn, & Lee, 2020; Y. Li, Zhang, Wang, & Chen, 2019; Moon & Hwang, 2018).

The four main types of crowdfunding are donation-based, reward-based, lending-based, and equity-based. What investors receive for their contributions, the legal complexity, and the degree of information asymmetry fundraisers and investors are varied among these types (Bi et al., 2017). Investors are also called funders or backers. Entrepreneurs could bring their ideas to reality by placing projects on crowdfunding platforms (CFPs) to raise funds from investors (Bi et al., 2017; Q. Zhao, Chen, Wang, & Chen, 2017). Projects could range from the production of cultural or artistic content to the establishment of startups (Moon & Hwang, 2018). The success of crowdfunding platforms has been received significant attention from academics and practitioners (Thies et al., 2014).

This research focuses on reward-based CF because it is the largest crowdfunding in terms of the total number of CFPs, but few studies have been devoted to it so far (Gierczak, Bretschneider, & Leimeister, 2014; Thies et al., 2014). In reward-based CF, funders receive non-monetary rewards such as products instead of financial incentives, returns, or repayment in return (Bi et al., 2017; H. Kim & Chang, 2020; Moon & Hwang, 2018). Reward-based and donation-based CFPs are the most prominent types that attract substantial funds (Thaker, Thaker, & Pitchay, 2018). According to Statista Inc. (2020b), US\$5.5 billion was raised through reward-based and donation-based crowdfunding globally in 2017. The global crowdfunding market is striking. It is forecasted to reach US\$39.8 billion in value in 2026 (Statista Inc., 2020a). Asia is also the world’s second-largest CF market (Q. Zhao et al., 2017). Nevertheless, the success rate of CF projects on most platforms is surprisingly low (less than 50 %) (Herrero, Hernández-Ortega, & San Martín, 2020; Q. Zhao et al., 2017). Thus, understanding why backers support projects is crucial for the future of crowdfunding (Y. Li et al., 2019). We can bring such rationales to the light to socially supports most of initiatives in the platform.

Investors' or backers' behavior to fund projects online in reward-based CFPs generally like consumers buying goods because the business model of reward-based CF is pre-selling (Bi et al., 2017; Gierczak & Nitze, 2015). The funding process on reward-based CFPs is also comparable to the buying process on e-commerce platforms (Gierczak et al., 2014). Consumer decision-making styles determine consumers' attitudes and shopping behavior and are useful for market segmentation (Jain & Sharma, 2015; Khare, Khare, Mukherjee, & Goyal, 2016; C. Yang & Wu, 2007). The consumer style inventory (CSI), to evaluate consumer shopping behavior, provides rich information to understand a consumers' decision process and how they are influenced to make choices (Dash & Sarangi, 2008; Song Yang, Ding, & D'Alessandro, 2018). By this fashion, we can leverage this analogy to understand the backers and influence them to donate.

Reward-based CF provides non-monetary returns and has no well-defined regulations to protect backers like other CFs (Zheng et al., 2016). In crowdfunding platforms, funders are both customers and investors. Therefore, funders may encounter risks of not receiving the rewards expected. The customer behavior literature identifies perceived risk as one of the most frequent factors influencing online shopping behavior (Berglin & Strandberg, 2013). Besides, crowdfunding studies indicate that funders' perceived risk plays an important role in their investment decision (M. J. Kim et al., 2020; Q. Zhao et al., 2017). Perceived risk also tends to impact customers' decision-making in shopping, but it could be changed when customers' lifestyles change (Seo & Moon, 2016).

Although the funding process is conducted online, offline shoppers' attitude towards reward-based CF is interesting to be studied due to the following reasons. There are significant differences between online and offline shoppers (Frost, Goode, & Hart, 2010; Ganesh, Reynolds, Luckett, & Pomirleanu, 2010; Xu & Huang, 2014). For example, the key determinants of shopper types (online/ offline) are consumers' price consciousness and sale proneness (S.-F. Yu, 2008). Offline shoppers are more concerned with the ordering time and price component i.e. delivery cost and are sensitive to quality issues than online shoppers (Wilson-Jeanselme & Reynolds, 2006). Trust, interface and empathy significantly affect customers' intention to shop offline, but not their intention to shop online (Suryandari & Paswan, 2014). Hence, different strategies for each group are needed because of their individualistic and perception differences (Arce-Urriza, Cebollada, & Tarira, 2017; Broekhuizen & Jager, 2004; Frost et al., 2010; Xu & Huang, 2014).

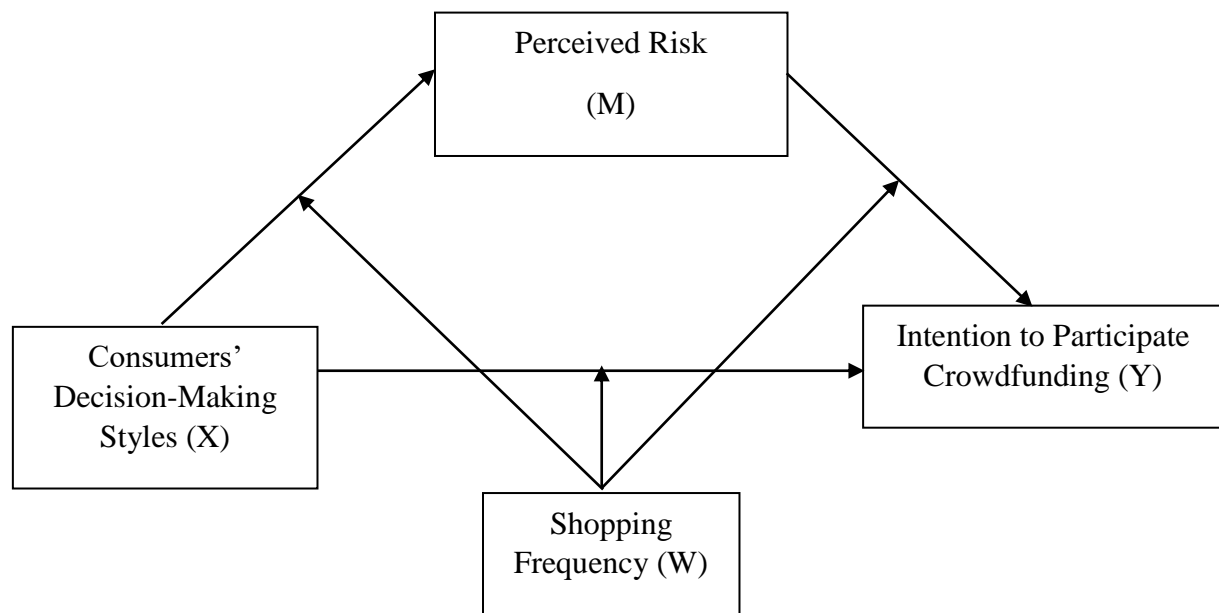
Consumer decision-making styles have not been widely studied in online contexts (Park & Gretzel, 2010). They are also suggested to be tested among countries (Dash & Sarangi, 2008). Previous studies mainly explore consumer decision-making styles as the behavioral characteristics of customers rather than their influence on online shopping behavior, for instance, the study of Tjhin and Murad (2017), Bae, Pyun, and Lee (2010), Bandara (2014), Jaidev and Amarnath (2018), and Wanninayake (2019). Few studies analyze factors affecting the CF project success from funders' perspectives and from the perspective of positive and negative factors (Y. Li et al., 2019; Q. Zhao et al., 2017). Past research also does not examine how factors interact with each other when potential investors make the decision to support a reward-based CF project (Herrero et al., 2020). Studies related to CF adoption in different contexts are quite a few (Deepika, Gunawardane, & Weerakoon Banda, 2019). Gunawan, Susanto, Raci, and Gunadi (2019) also guide future research to explore CF in emerging countries and focus on a specific type of CFPs.

To address the above research gaps, the purpose of this study is to explore the roles of consumer decision-making styles and perceived risk in the fundraising on Indiegogo from funders' perspectives (offline shoppers in Thailand). Indiegogo is one of the largest reward-based CFPs (Thies et al., 2014). Major research questions are: RQ1: What are the relative impacts of consumer decision-making styles and perceived risk on backers' intention to support reward-based CF campaigns? RQ2: How do these impacts vary for backers who conduct offline shopping frequently compared to those who do not? This work is one of the few studies that focus on funders' intention to make a pledge in a specific CFP in Thailand. This study provides a novel empirical investigation of how the interactions of positive and negative factors determine reward-based CF success. Focusing on offline shoppers as target backers are also expected to expand insights of crowdfunding literature.

HYPOTHESES DEVELOPMENT

Intention to Participate in a Crowdfunding Project

Financial-contribution intention is a person's intention to provide monetary backing to a CF campaign. Financial-contribution intention significantly enhances his/ her financial-contribution behavior (Shneor & Munim, 2019). In reward-based CF, backers give funding to people, projects, or organizations in exchange for non-monetary benefits such as rewards, products, or services (Shneor & Munim, 2019). Reward-based CF shares several characteristics with pre-selling or pre-ordering in traditional product markets (Steigenberger, 2017). Pre-selling in reward-based CF looks like a business-plan pitching rather than advertising products (Shneor & Munim, 2019). The project owner has to visualize how prosperous the project is and encourage the backer to invest in the project. Moreover, since the backer is not only interested in the consumption or enjoyment of such promised reward, the creator may need to address the social value where the backer can support the growth of project which could potentially contribute to the society.



Notes. X = independent variable; Y = dependent variable; M = mediator; W = moderator

Figure 1. The Proposed Moderated Mediation Model

Figure 1 presents the research framework.

Consumer Decision-Making Styles

Perceptions and behaviors about new technologies e.g., crowdfunding tend to be defined by an individual's personality (H. Kim & Chang, 2020). Consumer decision-making styles or shopping styles refer to mental orientations, which define a consumer's approach to make decisions about goods or services in the marketplace (GÖKCEK, ÇARIKÇIOĞLU, & YÜKSEL, 2019; Park & Gretzel, 2010; Sarkar, Khare, & Sadachar, 2019; J. Yu & Zhou, 2009). Different consumers apply diverse decision-making styles when evaluating products or services (GÖKCEK et al., 2019). Decision-making styles are important factors in consumer purchase decision (Park & Gretzel, 2010). They also significantly affect customers' satisfaction (GÖKCEK et al., 2019) and online shopping behaviors (Khare, 2016; Park & Gretzel, 2010). Understanding the basic characteristics of consumer decision-making styles is essential for marketers and advertisers (GÖKCEK et al., 2019; J. Yu & Zhou, 2009).

Sproles and Kendall (1986) collect related traits to develop consumer decision-making styles called consumer style inventory (CSI). Eight consumer styles consist of perfectionistic, brand conscious, novelty-fashion conscious, recreational shopping conscious, price-value conscious, impulsive, confused by over-choice, and habitual, brand-loyal consumer characteristics. CSI is tested in several contexts such as local retail stores, mall, and online shopping (Park & Gretzel, 2010; Sarkar et al., 2019). Yet, CSI factors are slightly different in cross-cultural studies (Tanksale, Neelam, & Venkatachalam, 2014). For example, online shoppers are classified into 6 CSI dimensions (C. Yang & Wu, 2007). Digital camera consumers are categorized into 7 CSI dimensions in the study of (Hung & Tu, 2010). Four shopping styles are reported in the shopping behavior of Chinese consumers (Khare et al., 2016). A part of CSI is also applied to some context such as social commerce (Sarkar et al., 2019) and retails (Sarkar et al., 2019). Some studies combine CSI or propose new decision-making styles (Childs, Turner, & Watchravesringkan, 2019; Helmi, 2016; Sarkar et al., 2019; Zhou, Arnold, Pereira, & Yu, 2010).

Some study selects only one CSI dimension (price consciousness) to understand the comparison behavior of grocery shoppers in Croatia (Park & Gretzel, 2010). The study of Sarkar et al. (2019) mentions only four shopping styles including brand consciousness, novelty and fashion consciousness, recreational and hedonistic shopping, and brand loyalty. The present study adopts five decision-making styles because they are found relevant to retail contexts in developing markets including fashion consciousness, brand consciousness, quality consciousness, recreational/ hedonistic consciousness, and price consciousness (Khare et al., 2016; Mehta & Dixit, 2016; Sarkar et al., 2019; Song Yang, 2017). Fashionable factors significantly affect perceived risk (Song, Kong, & Wang, 2011). Novelty-fashion consciousness is proposed to influence a user's perceived risk of mobile shopping apps (Sarkar et al., 2019). Customers' intention regarding fashion significantly reduces their perceived risk (W. W. Yu et al., 2011). Brand awareness significantly influence perceived risk (Song et al., 2011). Brand consciousness also a significant driver of users' perceived risk from mobile shopping apps (Sarkar et al., 2019). Perceived risk are significantly reduced by a customer's intention on brand (W. W. Yu et al., 2011). Perceived product quality significantly increase backers' funding intention (Z. Wang & Yang, 2019). The pursuit of high-quality factors also affect perceived risk (Song et al., 2011). Perfectionist high-quality consciousness significantly associates with the perceived risk of mobile shopping application users (Sarkar et al., 2019). Hedonic value is a predictor of CF success (H. Kim & Chang, 2020). Recreational/ hedonistic shopping consciousness influences the perceived risk of mobile shopping app users (Sarkar et al., 2019). Price concession positively affects PNGA, which increases satisfaction. Satisfaction significantly increases purchase intention towards CF products or

services (Y. Li et al., 2019). Price-sensitive factors have significant effects on perceived risk (Song et al., 2011). Price-value conscious consumers significantly negatively relate to perceived value and perceived financial risk (Hung & Tu, 2010).

The Mediating Role of Perceived Risk

Perceived risk negatively affects a decision maker's willingness to perform a risky behavior such as purchasing online (Dabrynin & Zhang, 2019; D. J. Kim, Ferrin, & Rao, 2008; Nicolaou & McKnight, 2006). Perceived risk in an online context such as internet shopping could be economic loss, times, anxieties about a product or service, and information privacy. It leads to negative customer satisfaction and customer resistance to online technologies (Seo & Moon, 2016). A higher risk forces a customer to find more information and alternatives to reduce it, so it strongly impacts his/ her purchase intention (Dabrynin & Zhang, 2019). It plays a crucial role in online shopping when consumers search for products or services online as well (Dabrynin & Zhang, 2019; Seo & Moon, 2016). Product risk, financial risk, and privacy risk in online shopping are significantly negatively related to shoppers' purchase intention (Dabrynin & Zhang, 2019; Yi & Fan, 2011). Perceived risk in online group buying (OGB) decreases a customer's willingness to use online shops or services. It also significantly decreases OGB purchase intentions (Cheng, Tsai, Cheng, & Chen, 2012). Past research indicates that the perceived risk of m-commerce is more important for consumers in developing countries than for those in developed countries (Sarkar et al., 2019). There are significant relationships among perceived risks, i.e., quality risk, social risk, financial risk, time risk, privacy risk, and delivery risk, and online shopping intention (Javiya, 2017). In electronic data exchange, the effect of perceived information quality on intention is significantly mediated by trusting beliefs and perceived risk (Nicolaou & McKnight, 2006). In the e-commerce context, the impact of trust on a consumer's intention to purchase is mediated by perceived risk (D. J. Kim et al., 2008). Past research confirms the mediation effect of perceived risk on satisfaction and loyalty (Marakanon & Panjakajornsak, 2017).

Backers have to make risky decisions about their monetary contributions (Moradi & Dass, 2019). Their perceived risks could decrease their funding intention (Moon & Hwang, 2018; L. Zhao & Vinig, 2019; Q. Zhao et al., 2017). Perceived risks i.e., performance risk and psychological risk are barriers to positive decision-making in the CF context, so CF practitioners should try to reduce funders' perceived risk e.g., adding high levels of value and credibility to the brand and products and making them visible in the market to achieve awareness to reduce the funder's anxiety (H. Kim & Chang, 2020; H. Wang & Kim, 2017). Investors' perceived risk could hinder their willingness to invest in an equity CF (Pan & Liu, 2018). Reward-based CF involves risks of non-delivery, late delivery, or deviating delivery on promises made by project creators (Shneor & Munim, 2019). Perceived risk is proposed to negatively affect the attitudes toward reward-based CF projects and platforms (Gierczak & Nitze, 2015). Perceived risks on backing behavior, which associate with the funding object, the project initiator, and the project intermediary, are proposed to influence funding on revocation in reward-based crowdfunding (Gierczak et al., 2014), as a result, the following hypothesis is considered:

H1: Perceived risk would mediate the association between consumer decision-making styles and intention to participate in crowdfunding.

The Moderating Role of Shopping Frequency

The experience causes a reduction in perceived risk in an online purchase. Customer experience significantly decreases product risk, financial risk, privacy risk, and online purchase intention (Dabrynin & Zhang, 2019). Customer experience also significantly generates online purchase intention (Maitlo, Jugwani, & Gilal, 2017) and the frequency to buy in an e-tailing setting (Opreana, 2013). Positive or negative experiences of users with mobile services affect their perceptions toward the services in general. Mobile phone experience is proposed to negatively moderate the relationship between service awareness and perceived risk (Alkhalidi, 2017). Consumers' attitudes toward online shopping are significantly influenced by their familiarity and the use of online shopping websites (Khare, 2016). Improving potential consumers' skills and experience of using computers and the Internet can reduce the perceived risk in online shopping (Handa & Gupta, 2014). Frequency of online shopping implies consumer's experience in online shopping and eventually minimize perceived risk. A consumer's familiarity (FAM) with a selling party also significantly increases his/ her intention to purchase (D. J. Kim et al., 2008).

Shopping frequency indicates consumers' engagement and loyalty to a brand. It also links to security, close relationships, excitement, and enjoyment during the purchase (Cachero-Martínez & Vázquez-Casielles, 2018). Purchasing frequency affects purchase behavior (Lin, Wei, & Lekhawipat, 2018). The increasing frequency of purchase reduces perceived risk and enhances the chance of repetitive purchasing (Mortimer, Fazal e Hasan, Andrews, & Martin, 2016). Consumers' intention to use m-shopping services and websites improves when shopping frequency increases (Wen, Li, & Yin, 2019). Consumers with dissimilar purchase frequencies may differ in their degree of sensitivity to prices and promotions (Arce-Urriza et al., 2017). Frequent and infrequent online shoppers perceive e-tailing quality dimensions differently (Sebastianelli, Tamimi, & Rajan, 2007). Frequently purchase online moderates the relationship between consumer shopping style and online shopping behavior (Khare, 2016). Shopping frequency moderates the influence of perceived web-visual aesthetics on aesthetic-experience value (Tseng & Lee, 2019). The frequency of visiting retailers' stores significantly moderates the positive impact of marketing experiences on consumer engagement (Cachero-Martínez & Vázquez-Casielles, 2018). Online shopping frequency significantly moderates the relationship between the atmosphere and the subjective norm in the context of sustainable consumption (Shuai Yang, Li, & Zhang, 2018). It also significantly increases online shopping transactions and perceived satisfaction with the delivery service (Xiao, Wang, & Liu, 2018). Based on previous reports, the following hypothesis is formulated:

H2: Shopping frequency would moderate the relationship between a) consumer decision making styles and perceived risk, b) perceived risk and intention to participate in crowdfunding, and c) consumer decision making styles and intention to participate in crowdfunding.

METHODOLOGY

This study is a sub-project of the CROWDFUNDING project. The sample of this study was offline shoppers who had never made a purchase online in the past 6 months. To ensure that respondents were indeed offline shoppers, a sentence with asterisks at the beginning and the end to confirm that he/ she had never conducted an online purchase within the past 6 months was presented. Otherwise, a respondent was guided to reject answering the questionnaire. The privacy and anonymity of respondents were specified to be safeguarded at the introductory part. The online questionnaire was administrated through Google Form. Data from participants was collected voluntarily by research assistants. Male and female data were collected in around the same number to decrease the effects of gender on decision-making styles (C. Yang & Wu, 2007), the intention to participate in CF (Gunawan et al., 2019), or online shopping behavior (Berglin & Strandberg, 2013). The research instrument was written in Thai. The definition of crowdfunding and the captured screens of a project on the reward-based CF platform (Indiegogo) are presented in the Introductory part. Twenty-one items were applied to capture the constructs and 6 items to collect demographic data regarding respondents' gender, age, shopping behavior, and shopping preferences.

Five consumer styles were adopted comprising of fashion consciousness, brand consciousness, quality consciousness, recreational/ hedonistic consciousness, and price consciousness. The fashion-conscious consumer was a consumer who appeared to like new and innovative products and experienced excitement from seeking out new things. The brand-conscious consumer was a consumer who was oriented towards buying expensive or well-known brands. The quality-conscious consumer is a consumer who searched carefully and systematically for products with the best quality. The recreational/ hedonistic-conscious consumer was a consumer who found shopping a pleasant activity and did shopping just for fun. The price-conscious consumer was a consumer who generally had a high sensitivity to sale prices and lower prices (Jain & Sharma, 2015).

All items were measured using a 5-point scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Five consumer decision-making styles were measured using 15 items adapted from (Khare et al., 2016; Mehta & Dixit, 2016; Song Yang, 2017). An example item of fashion consciousness was "I usually have one or two stuff of the very newest fashions.". An example item of brand consciousness was "I prefer buying the reputed brands.". An example of quality consciousness was "When it comes to purchasing products, I try to get the very best or perfect choice.". An example item of recreational/ hedonistic consciousness was "I enjoy shopping just for the fun of it.". An example item of price consciousness was "The lowest-price products are usually my choice.". Three items measuring perceived risk and 3 items measuring intention to participate in a CF project were adapted from Chiu, Wang, Fang, and Huang (2014) and Lu and Rastrick (2014) respectively. An example item of perceived risk was "It is likely that shopping on the crowdfunding website will cause me to lose control over the privacy of my personal and payment information.". An example of intention to support CF was "Given the opportunity, I intend to place a purchase from the crowdfunding website.". The questionnaire was designed to be similar to CSI and other items from literature, with minor changes according to CF contexts.

Data analyses started by providing descriptive statistics. Then, content validity and reliability were explored to evaluate the psychometric properties of scales in the study. Finally, mediation and moderated-mediation hypotheses were tested using Hayes' PROCESS analyses (Hayes, 2018).

RESULTS

Respondents' Profile

A total of 275 responses are received. Duplicate records and records with outliers are excluded. Finally, a total of 218 valid questionnaires are gathered. Most respondents are female (51.8%) in the age group of 20-29 years (58.3%). Generally, many respondents conduct shopping 1-5 times per month (84.9%) with a mean time of 3. Most of them (26.1%) normally spent 401-600 baht each time with average spending of 758 baht. Respondents prefer payment systems such as PayPal (61.5%), ACH bank transfer (59.6%), and credit/ debit card (48.2%) respectively. The top five product categories that respondents possibly support were women's or men's fashion (68.3%), technology or electronics (41.3%), health or beauty (36.2%), comics or books or magazines (20.2%), and sports or traveling (16.5%) consecutively. Most respondents (34.9%) are willing to support a product on reward-based CF approximately \$1-\$5 per project, as shown in Table 1.

Table 1. Demographic Analysis Results (n = 218)

Classification	Items	Frequency	Percentage
Gender	Male	105	48.2
	Female	113	51.8
Age	Less than or equal 19	69	31.2
	20-29	127	58.3
	30-39	10	4.6
	40-49	6	2.8
	50-59	6	2.8

Classification	Items	Frequency	Percentage
Shopping Frequency (Times per Month)	More than or equal 60	1	0.5
	Less than 1	12	5.5
	1-5	185	84.9
	6-10	16	7.3
	11-15	2	0.9
	More than 15	3	1.4
Average Spending per Time (Baht)	Less than or equal 200	53	24.3
	201-400	32	14.7
	401-600	57	26.1
	601-800	6	2.8
	801-1000	38	17.4
	1001-1200	2	0.9
	1201-1400	1	0.5
	More than 1400	29	13.3
Preferred Payment Method	Payment Systems such as PayPal	134	61.5
	ACH Bank Transfer	130	59.6
	Credit/Debit Card via Stripe	105	48.2
	Others	11	5.0
Tentative Product Categories to be Supported	Women's/ Men's Fashion	149	68.3
	Technology/ Electronics	90	41.3
	Health/ Beauty	79	36.2
	Comics/ Books/ Magazines	44	20.2
	Sports/ Traveling	36	16.5
	Electrical Appliances/ Home Appliances	33	15.1
	Music/ Entertainment Media	25	11.5
	Children/ Toys	15	6.9
	Arts/ Crafts	11	5
	Automotive	6	2.8
Average budget to support reward-based CF per project (\$ 1 approximately 35 Baht)	\$1-\$5	76	34.9
	\$6-\$10	59	27.1
	\$11-\$25	50	22.9
	\$26-\$50	13	6.0
	\$51-\$100	14	6.4
	\$101-\$500	3	1.4
	\$501-\$1000	2	0.9
	\$1001-\$5000	1	0.5
	More than \$5000	0	0.0

Preliminary Analysis

Table 2. Descriptive Statistics for Items and Loadings from Factor Analysis (n = 218)

ID	Mean	SD	F1	F2	F3	F4	F5	F6	F7
CSI: Overall	3.41	.541							
CSI: Fashion Consciousness ($\alpha = .827$)	3.21	.860							
CSI_FASHION1	3.20	1.005				.796			
CSI_FASHION2	3.33	.905				.744			
CSI_FASHION3	3.11	1.078				.807			
CSI: Brand Consciousness ($\alpha = .720$)	3.18	.764							
CSI_BRAND1	3.29	.911					.647		
CSI_BRAND2	2.92	1.038					.729		
CSI_BRAND3	3.23	.908					.779		
CSI: Quality Consciousness ($\alpha = .837$)	3.79	.739							
CSI_QUAL1	3.73	.861			.845				
CSI_QUAL2	3.86	.825			.885				
CSI_QUAL3	3.77	.865			.767				
CSI: Recreational/ Hedonistic Consciousness ($\alpha = .909$)	3.36	.954							
CSI_HEDO1	3.42	1.045	.833						
CSI_HEDO2	3.37	1.023	.863						

ID	Mean	SD	F1	F2	F3	F4	F5	F6	F7
CSI_HEDO3	3.29	1.046	.872						
CSI: Price Consciousness ($\alpha = .550$)	3.56	.748							
CSI_PRICE2	3.62	.924							.774
CSI_PRICE3	3.49	.876							.790
Perceived Risk ($\alpha = .663$)	3.25	.730							
PR1	3.18	.952						.819	
PR2	3.29	.913						.765	
PR3	3.28	.968						.688	
Intention to Participate in Crowdfunding ($\alpha = .885$)	3.24	.853							
INT_PERK1	3.24	.940		.895					
INT_PERK2	3.22	.965		.874					
INT_PERK3	3.24	.935		.807					
Eigenvalue			2.667	2.546	2.508	2.312	1.904	1.810	1.427
% of Total Variance			13.336	12.729	12.540	11.561	9.522	9.050	7.135
Total Variance			75.873						

Table 3. Component Correlation Matrix

	CSI_FASHION	CSI_BRAND	CSI_QUAL	CSI_HEDO	CSI_PRICE	PR	INT_PERK
CSI_FASHION	1						
CSI_BRAND	.577**	1					
CSI_QUAL	.191**	.191**	1				
CSI_HEDO	.511**	.394**	.224**	1			
CSI_PRICE	-.028	.101	.353**	.096	1		
PR	.205**	.173*	.046	.159*	.045	1	
INT_PERK	.289**	.299**	.195**	.388**	.228**	-.122	1

Notes. * $p < 0.01$ ** $p < 0.05$

Initially, the factorability of the 21 items is examined. Principal component analysis and varimax rotation are adopted. Seven factors are identified consisting of fashion consciousness, brand consciousness, quality consciousness, recreational/ hedonistic consciousness, and price consciousness, perceived risk, and intention to support reward-based CF projects. One item of price consciousness is dropped as its factor loading less than 0.5. The Kaiser-Meyer-Olkin measure of sampling adequacy is .806, above the commonly recommended value of .6, indicating that the proportion of variance in variables caused by underlying factors. Bartlett's test of sphericity is significant ($\chi^2(190) = 2110.562, p < .001$). Hence, the correlations between indicators are sufficient thereby being suitable for factor analysis. The cumulative variance is 75.87%, indicating that seven extracted factors could explain the original items in the large extent of information. Table 2 presents means, standard deviations, and the factor loadings, which are greater than 0.5. Cronbach's alpha values range from a minimum value of 0.550 and a maximum value of 0.909, indicating acceptable internal consistency (Nunnally, 1978; Omar et al., 2011). Table 3 shows the correlation matrix of seven factors. It indicates that there are significant correlations between some model variables in the hypothesized direction.

The above results show support for the psychometric properties of the instruments used, allowing them to be confidently analyzed further. However, the hypotheses to investigate causal effects are defined at the construct level, so the analyses should be conducted at the construct level, not at the dimensional level (Wong, Law, & Huang, 2008). Hence, items of CSI are summed up and used as a variable in further analyses (Konietzny & Caruana, 2019). Besides, the study of Song et al. (2011) emphasizes the important assumption of CSI that every consumer considers not only one factor. All factors affect them, but they pay more attention to one or a few factors in their comprehensive decision. Several studies combine items from the CSI factors and present new factors such as the study of Kumar, Belwal, and Raina (2019) and the study of Aliman, Ariffin, and Hashim (2018)

Testing of Mediation

Table 4. Test of the Mediation Effect (n = 218)

Predictors		(Y) Intention to Participate in Crowdfunding (INT_PERK)			(M) Perceived Risk (PR)			(Y) Intention to Participate in Crowdfunding (INT_PERK)		
		b	se	t	b	se	t	b	se	t
(X) Consumer Style Inventory (CSI)		0.689	0.097	7.142***	0.276	0.090	3.073**	0.760	0.096	7.927***
(M) Perceived Risk (PR)								-0.258	0.071	-3.628***
Constant		0.884	0.333	2.655**	2.307	0.310	7.439	1.479	0.363	4.073***

Predictors	(Y) Intention to Participate Crowdfunding (INT_PERK)			(M) Perceived Risk (PR)			(Y) Intention to Participate Crowdfunding (INT_PERK)		
	<i>b</i>	<i>se</i>	<i>t</i>	<i>b</i>	<i>se</i>	<i>t</i>	<i>b</i>	<i>se</i>	<i>t</i>
R^2	0.191			0.042			0.238		
F	51.007			9.442			33.518		

Notes. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

The mediation effect of perceived risk on the association between consumer decision-making styles and intention to participate in a CF project is tested. The result is presented in Table 4. CSI significantly positively affects intention to participate in CF ($b = 0.689$, $p < 0.001$) and perceived risk ($b = 0.276$, $p < 0.01$). Besides, when CSI ($b = 0.760$, $p < 0.001$) and perceived risk ($b = -0.258$, $p < 0.001$) are predictors, they show significant impacts on intention to participate in CF.

The analysis of bias-corrected bootstrapping with 5,000 samples using Model 4 of Hayes' PROCESS macro reveals a total effect of CSI on intention to participate in CF [$B = 0.69$, $SE = 0.10$, 95%CI (0.50, 0.88)] and a significant mediation effect of perceived risk [$B = -0.71$, $SE = 0.03$, 95%CI (-0.14, -0.02)]. CSI also shows a significant direct effect on intention to support a CF project [$B = 0.76$, $SE = 0.10$, 95%CI (0.57, 0.95)]. Therefore, perceived risk partially mediates the relationship between CSI and intention to purchase a product on reward-based CF, supporting Hypothesis 1.

Testing of Mediation

Table 5. Results from Moderated-Mediated Multiple Regression Analysis (n = 218)

Predictors	(M) Perceived Risk (PR)			(Y) Intention to Participate Crowdfunding (INT_PERK)		
	<i>b</i>	<i>se</i>	<i>t</i>	<i>b</i>	<i>se</i>	<i>t</i>
(X) Consumer Style Inventory (CSI)	0.288	0.089	3.230**	0.773	0.096	8.032***
(M) Perceived Risk (PR)				-0.296	0.075	-3.952***
(W) Shopping Frequency (FQ_BUY)	-0.034	0.014	-2.371*	-0.029	0.017	-1.728
CSI → PR x FQ_BUY	-0.035	0.028	-1.245			
PR → INT_PERK x FQ_BUY				-0.034	0.030	-1.119
CSI → INT_PERK x FQ_BUY				0.001	0.030	0.026
Constant	0.003	0.048	0.065	3.223	0.052	62.248***
R^2	0.069			0.249		
F	5.254			14.054		

Notes. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

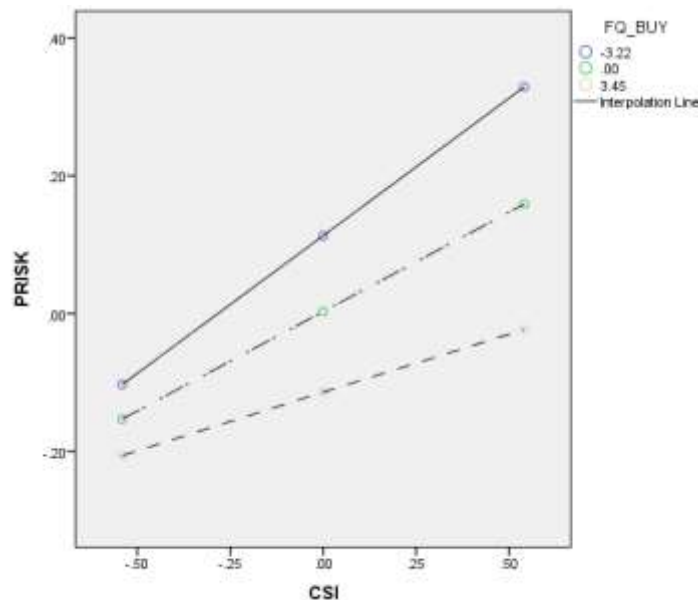


Figure 2. A Visual Representation of the Moderation of the Effect of Consumer Styles (X) on Perceived Risk (M) by Shopping Frequency (W)

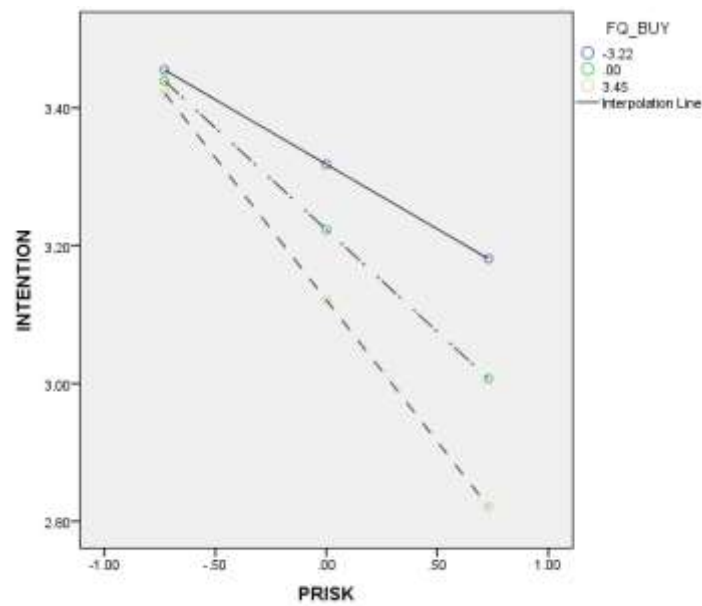


Figure 3. A Visual Representation of the Moderation of the Effect of Perceived Risk (M) on Intention to Participate in Crowdfunding (Y) by Shopping Frequency (W)

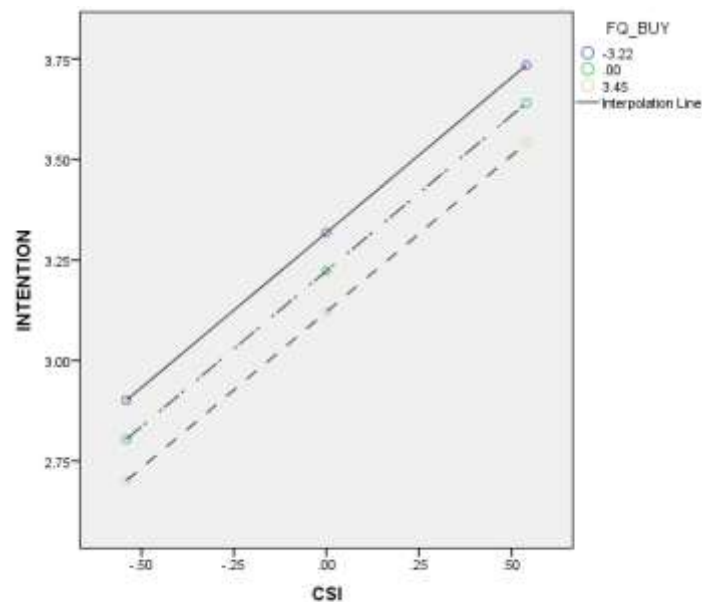


Figure 4. A Visual Representation of the Moderation of the Effect of Consumer Styles (X) on Intention to Participate in Crowdfunding (Y) by Shopping Frequency (W)

Model 59 of Hayes' PROCESS macro is employed to explore whether the mediation effect of perceived risk is moderated by shopping frequency. The macro enables the analysis of complex models with mediation and moderation. As shown in Table 5, perceived risk is significantly influenced by CSI ($b = 0.288$, $p < 0.01$) and shopping frequency ($b = -0.034$, $p < 0.05$), but not by the interaction effect of CSI and shopping frequency. The direct effects of CSI ($b = 0.773$, $p < 0.001$) and perceived risk ($b = -0.296$, $p < 0.001$) on intention are significant. However, the moderation effects of shopping frequency on the CSI-perceived risk and CSI-intention relationships are insignificant. Figure 2 to Figure 4 also show the moderation effects of shopping frequency on CSI-perceived risk relationship, perceived risk-intention relationship, and CSI-intention relationship, respectively. Graphs are represented in three levels: 1 standard deviation below the mean, 0 standard deviation, and 1 standard deviation above the mean. They are applied for descriptive purposes only. When the shopping frequency is high, the slope of the relationship between CSI and perceived risk is less positive than respondents having low shopping frequency. On the contrary, the slope of the relationship between perceived risk and intention is more negative in respondents with high shopping frequency than those with low shopping frequency. Yet, the slopes of the relationship between CSI and intention are indifferent whether the shopping frequency is low or high. However, these moderation effects are not significant. Thus, Hypothesis 2 is not supported.

Discussion

Table 6: The summary of research results.

Hypothesis	Result
H1: Perceived risk would mediate the association between consumer decision-making styles and intention to participate in crowdfunding.	Support
H2: Shopping frequency would moderate the relationship between a) consumer decision making styles and perceived risk, b) perceived risk and intention to participate in crowdfunding, and c) consumer decision making styles and intention to participate in crowdfunding.	Not support

Table 6 summarizes the main results of this work. This study finds that the consumer decision-making styles of offline shoppers increase the perceived risk, which in turn negatively associates with reward-based CF intention. In other words, perceived risk mediates the relationship between offline shoppers' CSI and their intention to support CF, consistent with the extant literature described in the section 'The Mediating Role of Perceived Risk'. This phenomenon could be explained by the backer's unfamiliarity or aversion to online transaction. The positive effect of CSI on perceived risk is in line with the study of Song et al. (2011) indicating the positive impacts of consumers' pursuit of high quality and customary shoppers on perceived risk. Besides, the respondents in this study are offline shoppers. They have never purchased products or services online, so they tend to have a greater suspicion of conducting transactions in online environments, especially the quality dimension. Positive correlations of five consumer decision-making styles and perceived risk are also shown in Table 2.

For the insignificance of shopping frequency as the moderators of CSI-perceived risk, perceived risk-intention, and CSI-intention relationships, this could be explained by the study of Lin et al. (2018) specifying that shopping frequency is an insignificant controlling variable with regard to repurchase intention at a specific time. The experience of using mobile phones has no positive moderating effects on the relationship between awareness of services and performance, the relationship between awareness of services and effort expectancy, and the relationship between awareness of services and perceived risk (Alkhalidi, 2017). Only perceived trust significantly affects the backing intention of respondents without prior CF experience, whereas both perceived trust and perceived risk of a platform significantly impact backing intention in those with prior CF experience (Moon & Hwang, 2018). On one hand, shopping frequency may significantly effects repurchase intention in a certain context because it may increase the buyer's skill and literacy in investigating the authenticity of online merchants and their products and services. On the other hand, shopping frequency may not significantly influence purchase intention since, in this context, the consumers or backers perceive this purchase as giving or supporting to the project creators. They may not only expect the rewards but also contribute to the construction of different projects they are interested in. In this fashion, whether the backers will repeat their contribution depends on the project's growth and its' promised rewards.

The result also shows the significant and negative influence of shopping frequency on perceived risk. Although the study of Kang, Bonn, and Cho (2015) pointing out that offline shopping is perceived to provide a better shopping experience from see-touch-handle, personal service, no-hassle exchange, and speedy delivery, compared to online shopping. The study of Cachero-Martínez and Vázquez-Casielles (2018) indicating that shopping experiences influence consumer engagement to a greater extent if they visit the retailer with some frequency. The frequency of the visit to retailers also significantly positively affect the experience dimensions of consumer engagement. Therefore, the perceived risk of online channels (CF platforms) could be lower if consumers do (offline) shopping more frequently. The current findings advance the understanding of offline consumers and their perceptions regarding a reward-based CF platform and reveal that perceived risk is one of the primary mediation mechanisms in a CF adoption model.

IMPLICATIONS

For theoretical implications, first, previous research has examined factors influencing CF intention, but few studies have been explored these factors using mediation and moderation models in a specific reward-based CF platform. Besides, this study is one of the first studies that explore the motivation of offline shoppers, who can be viewed as potential customers or future backers for CF platforms. Second, this study reveals the consumer decision-making styles of research samples from Thailand. It fills the gap of required cross-cultural studies on consumer decision-making styles mentioned in the study of Song Yang et al. (2018) and the study of Dash and Sarangi (2008), which are crucial for marketers. Third, five consumer decision-making styles are extracted from factor analysis: fashion consciousness, brand consciousness, quality consciousness, recreational/ hedonistic consciousness, and price consciousness, confirming the CSI factors from the past studies (Khare et al., 2016; Mehta & Dixit, 2016; Sarkar et al., 2019; Song Yang, 2017). Forth, CSI has been utilized to understand consumer decision-making styles across different retail contexts such as social networking sites, but not in crowdfunding (Sarkar et al., 2019). Findings show the direct and indirect effects of consumer decision-making styles on CF intention, lending support to CSI in the rewarded-based CF literature. Fifth, this research shows the significant impact of perceived risk as a mediator on the association between CSI and intention to participate in a CF project, so the perceived risk should be taken into account in the study of reward-based CF. Last, shopping frequency in offline channels does not have the expected moderation effects on relationships among CSI, perceived risk, and CF intention. On the contrary, it significantly affects perceived risk, confirming that it could be included in future research models to lower perceived risk. As addressed earlier, offline channels offer advantages to the buyers an immediate gratification of products. For this context, the buyers or backers realize that the reward or return from their contribution to the project on CF may be delivered as promised in the certain period of time in the future, so they may neglect an emergent usage. Moreover, the backer's perspectives on this transaction is not totally relating to purchase for consumption,

but also supporting the entrepreneurs to create products and services. By this regards, it could be said that perceived risks may decline even the backers may prefer offline channels.

Expanding the crowdfunding market to offline shoppers could improve the number of potential backers and actual backers on a CF project. Since several studies emphasize the differences between online and offline shoppers (Frost et al., 2010; Ganesh et al., 2010). This study guides practitioners to draw attention from offline shoppers as potential backers as followed. First, this study supports that reward-based CF platforms such as Indiegogo could be a marketing tool to acquire funding support from new funders such as offline shoppers. Second, CSI dimensions vary in different settings (Song Yang et al., 2018). This research reveals five decision-making styles of Thai offline shoppers that are recreational/ hedonistic consciousness, quality consciousness, fashion consciousness, brand consciousness, and price consciousness. The combination of these decision-making styles both directly and indirectly influence offline shoppers' acceptance of reward-based CF. Offline shoppers value quality, price, hedonic, fashion, and brand, respectively. Thus, project owners should not only focus on introducing high-quality products or services at low or reasonable prices but also on retain the return to invest in the growth of the project and amplification of its purposes. The shopping moments on the platform should be designed to be fun and entertaining, whereas the newest style and known brand tag should be also embedded in a product on each project. Third, factors responsible for the adoption of online platforms (mobile shopping apps) such as perceived risk differ across consumers with different decision-making styles (Sarkar et al., 2019). This study confirms the mediation effects of perceived risks. Perceived risks in terms of privacy invasion, financial loss, and failure to deliver products significantly decrease the potential backers' intention to support a CF project. Therefore, reward-based CF project owners should minimize these risks as much as possible. Since higher risk forces consumers to find more information (Dabrynin & Zhang, 2019). Privacy policy, warranty, and terms and conditions should be clearly defined on the CF project webpage to ensure backers' trust and confidence. Moreover, the awareness and reputation of the project creator are also essential to attract potential backers. Story telling of project creator's history must be well defined and communicated to enhance the potential backer's understanding and trust to the project. Forth, the perceived risk of offline shoppers is raised when the influence of CSI on their judgments increases. All CSI aspects are positively correlated with perceived risk, particularly fashion consciousness, brand consciousness, and recreational/ hedonistic consciousness. Hence, reward-based CF project owners should keep their eyes on potential backers with these decision-making styles who tend to perceive higher risks than others in their decision-making process. Presenting fashionable and attractive products, building brand reputation, and providing enjoyable experiences in CF platforms could help to promote their intention to support a product or service on CF. Last, offline shopping frequency significantly decrease future backers' perceived risk. Therefore, project owners should attract attention from offline shoppers who are quality-conscious and price-conscious and often shop in offline stores before any others. Promoting reward-based CF projects through offline channels that connect to the customer journey of these shoppers could increase the project successes.

CONCLUSION, LIMITATIONS, AND FUTURE RESEARCH

There is the call for theory refinement and intervention advancement (S. Li, Zhao, & Yu, 2019). Therefore, the moderated-mediation analysis in the CF study is increasingly important. This study contributes to the reward-based CF literature by investigating the consequences of consumer decision-making styles i.e., perceived risk and CF intention, which have been rarely observed in previous studies and empirically examine the mediating role of perceived risk and the moderating role of shopping frequency in the relationship between offline shoppers' decision-making styles and their intention to support a reward-based CF project. The research equips academics and reward-based CF project owners with theoretical and practical suggestions as well.

Although this study yields meaningful results, it has the following limitations. First, although it does not find evidence for the moderating role of shopping frequency, more research is needed before drawing a definitive conclusion to discount the importance of shopping frequency. Future studies should also examine the role of the web application/ mobile app use in altering the relationship between CSI, perceived risk, and intention, to compare and contrast the effects from online and offline means. Second, because reward-based CF is still an emerging market in Thailand, this study explores only backing intention, which may not be equal to actual purchase behavior. Future studies should explore from shoppers who purchase in offline retails more frequently than in online platforms but have ever supported a project on CF platforms to fill this research gap. Third, this study focuses on a reward-based CF platform i.e., Indiegogo. Future research should conduct to verify the research framework and its findings on other platforms such as Kickstarter or other CF platform types e.g., donation-based CF. Forth, this study gathers data from offline shoppers using online surveys and non-probability sampling. Future works should apply other sampling methods and other research methods to gain more insights from potential backers, to develop effective strategies to persuade them to participate in CF projects. Fifth, the research model could explain only 24.9% of offline shoppers' intention to support CF projects. Future research should explore other influential factors such as marketing mix, innovation attributes of products, and CF website design to gain more variance explained. Last, data used in this research is collected in Thailand, which may limit the generalizability of findings to other countries with different cultures and institutional contexts. Hence, future researchers should replicate this study in other Southeast Asian countries to extend these findings.

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An analysis of YouTuber's collaboration towards audience engagement

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ABSTRACT

YouTube has gained its popularity among audiences, and it has been efficiently used to reach mass audiences as same as tradition mass media i.e., television. Therefore, YouTube has become a main channel for marketers. The popularity of YouTube is significantly related to its content creators. Many people have become content creators or youtubers, who produce and publish massive contents on YouTube every day. Youtubers adopt many strategies to gain more attentions from the audiences. One of those strategies is youtubers or channel collaboration where more than one content creator appears in the content. This study aimed to investigate the influence of this kind of collaborative events towards the audience engagement. The observation method was conducted on 29 YouTube channels for three months. The results showed that collaborative events have significantly influence on audience engagement, number of views and followers. Game show was the most positive influential type of content. There was no significant difference between one-way and two-way relationship between YouTube channels. This study might contribute marketers and content creators in creating campaigns and contents, whereas offer deeper understanding in this phenomenon in terms of research.

Keywords: YouTuber, Para-social Interaction, Collaboration on YouTube, Audience engagement.

INTRODUCTION

YouTube has now shifted the way in which people consume video content since it offers better efficiency and effectiveness to reach target audiences. People do not need to wait until their preferred content is on air on a particular schedule. The content creators have more freedom to produce and publish their organic video contents without permission from television regulators. In 2021, there were approximately 7,000 YouTube channels with more than 100,000 subscribers and approximately 650 channels with more than one million subscribers in Thailand. These numbers indicated the increasing popularity of watching video contents via YouTube rather than via television. According to YouTube's guideline, there are 10 fundamentals i.e., shareable content, collaboration, discoverable topics, accessibility, consistency, targeting, sustainability, converse with viewers, interactive content, and authenticity (Google, 2015). Collaboration is among those ten fundamentals and has been popularly applied in creating content on YouTube. Exchanging appearances between YouTube channels helps gaining followers because this strategy introduces and exchanges followers between channels. Para-social relationship could be applied to help understanding this phenomenon (Niu et al., 2021a; Niu et al., 2021b; Rubin and McHugh, 1987). The co-appearance of more than one youtubers also increases YouTube channels popularity (Koch et. Al., 2018). During the pandemic, there were collaborations between 10 channels in Thailand, which each channel has different number of followers. They created a new channel, which produce different contents then their own original channels. This study aimed to exploring the exchanging appearance amount youtubers between their new collaborative channel and their own original channels. The observation was conducted to measure the impact of collaboration.

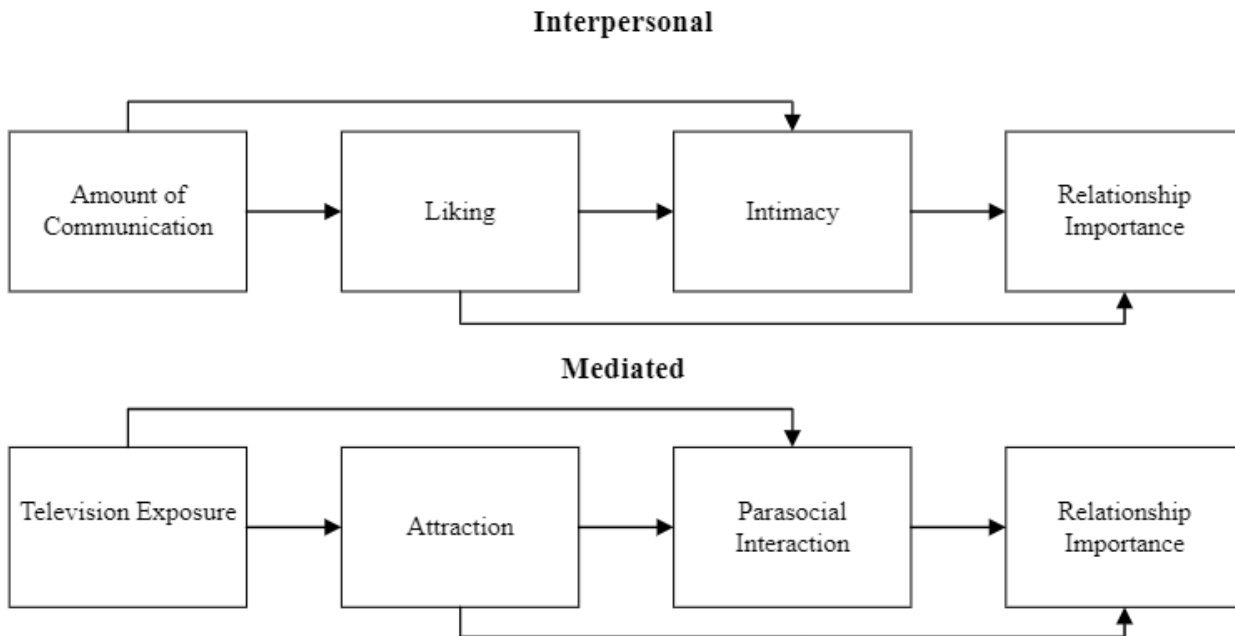
LITERATURE REVIEW

Collaboration

In digital era, collaboration is happened when more than one party agree to work together, which seems to be less formal than before (Arina and Rustiadi, 2018; Frey et al., 2006; Koch et al., 2018). People used social media platforms in learning and knowledge collaborations both formally and informally (Kaewkitipong et al., 2016; Ractham et al., 2012). However, there were more opportunities when adopting collaboration approach in different aspects for activities in digital platforms. For content creation, collaboration is one of 10 fundamentals, which is mentioned in the guideline for creating content people love (Google, 2015; Tafesse, 2020; Wisankosol, 2021). Koch et al. (2018) defined collaboration on YouTube as two youtubers internally or externally appear in each other channels. One youtuber could internally appear in the shows as a host, where another may externally appear in the shows as a guest. The collaboration does not mean that two youtubers need to appear together in the same scene. They can either appear together side by side or just in different scenes in the same clip. For example, a guest can appear in a short scene just to greet the host. Koch et al. (2018) also demonstrated the efforts to achieve analyzing data using image processing technology to detect the appearance of youtubers in 7,492 channels, which resulted in 1,599 channels with collaboration, which emphasized the growing number of collaborations in video content creations. This also highlighted the needs for automate analysis of video contents using technologies such as image processing, deep learning, and artificial intelligence.

Para-social Relationship

Horton and Wohl (1956) defined para-social relationship as the process to create relationship between characters on media (celebrities) and audiences (fan club). The audiences imaginatively treat their favorite celebrities as members of their network and seek more interactions and participations to gain emotional satisfactions. There were more factors, which indicate para-social relationship such as frequency of viewing and meeting. Isotalus (1995) stated that para-social relationship is one-way continuous viewing of characters on media with no feedback. The audiences perceived these characters like a friend and continuously watch those characters. Rubin and McHugh (1987) proposed a model to show the relationship development, which compare between interpersonal and mediated relationship. The more people communicate, the more they like each other, the closer they are and the more important relationship they development. It is the same for mediated relationship. The more the audiences watch, the more attractive they feel, the higher para-social interaction the relationship gain and the more important relationship the audiences have with their celebrities (See figure 1). Para-social relationship could be accelerated with collaboration between celebrities and their guests in the shows etc.



Source: Rubin and McHugh (1987).

Figure 1: Interpersonal and mediated relationship development.

Celebrity Culture on YouTube Platform

YouTube is considered as user generated content platform, which mean the content creators are responsible for creating content (Burgess and Green, 2018; Chau, 2010; Driessens, 2011). Moreover, the contents reflect the identity of the creators. The relationship is focusing mainly between content creators and consumers. This makes YouTube different from other social networks, which focusing more on building network and daily activities of their users. Furthermore, generating content on YouTube is far more resource consuming than on other social media platforms. The creators need to create their organic contents and develop relationship with their audiences at the same time. It could be seen that some part of the celebrity culture on YouTube platform was inherited from traditional media. But there are differences such as no regulators, no limit of channel owner. Some are still the same such as there is an award body or hall of fame, which will be given to youtubers with particular numbers of followers (see table 1). YouTube channel can also be classified as celebrity, professional, and amateurs (see table 2).

Table 1: Youtuber Category.

Categories	No. of Followers
Graphite	0 – 999
Opal	1,000 – 9,999
Bronze	10,000 – 99,999
Silver	100,000 – 999,999
Gold	1,000,000 – 9,999,999
Diamond	10,000,000 – 49,999,999
Ruby (Custom Creator)	50,000,000 – 99,999,999
Red Diamond	> 100,000,000

Source: YouTube Creator Award.

Table 2: Youtuber Level.

Level	No. of Followers
Celebrity	> 1,000,000
Professional	10,000 – 1,000,000
Amateurs	< 10,000

Source: Niu et al. (2021b).

Video Categories on YouTube Platform

Video categories on YouTube platform were classified in 15 types i.e., entertainment, people/blog, comedy, how-to & style, film and animation, education, music, science & technology, sports, gaming, news & politics, travel & events, cars & vehicles, pets & animal, non-profits & activism. The content creators use these categories to build up their initial audiences and channel loyalty (Bärtl, 2018; Holland, 2016). However, these categories do not cover overall content aspects. Niu et al., (2021a) proposed additional video style as in table 3.

Table 3: Youtuber Category.

Video Style	Descriptions
Artistic	Arts / Paints/ Performances / Animations
Challenge	Popular or adventurous activities
Chatting	Interactive live streaming with audiences
Game	Game live streaming
Homelife	Life at home and family
How-to	Guideline / teaching / learning i.e., cooking, languages etc.
Religious	Beliefs or prayers
Review	Product or service reviews
Story	Story telling or journey

Source: Niu et al. (2021a).

This research aimed to explore types of videos with collaboration, indicators and characteristics of collaboration, audience engagement towards collaboration. Moreover, the relationship between collaboration and engagement will be evaluated according to channel levels and video types.

RESEARCH METHOD

Data Collection and Samples

To explore collaboration on YouTube platform, this research conducted observational study on daily activities focusing on no. of views, likes and subscribers to monitor degree of changes of the popularity of YouTube channels between January – April 2022. The samples were chosen via purposive sampling, which are group of channels called “Yok Kam Lang”. This group consisted of 10 channels agreed to collaborate. They were Softpomz, Zommarie, PEACHII, Subsarb Production, Thep Lee La, Soundthis ST, Let’s Girl, Soloist, Pop Mai, and Na Nuad. In total, there were 11 channels (10 original channels + 1 collaborative channels). During data collection, if there is any additional youtubers join/appear in the collaborative channels, they will be included in the analysis.

Data Analysis

All data collected from daily no. of views, likes and subscribers on targeted YouTube channels were recorded in spreadsheet to keep track on changing accordingly. The authors also monitor news or any particular events apart from daily statistics to observe any cause of spike in no. of views, likes and subscribers. Google Collaboratory was used along with Python, Pandas and Matplotlib to visualize results. Furthermore, Microsoft Excel was used to conduct paired sample test for evaluating the differences between audience relationship.

RESULTS

Collaborative Events

From the observation, there were 446 videos, included in the analysis. 118 videos were collaborated with 193 collaborative scenes (there can be more than one collaborative scene in one video). 84 videos were one-way collaborations and 34 were two-way collaborations (see table 4). Figure 2 shows that there were 3, 4, and 5 channels, which collaborate in the same videos, whereas most videos were collaborated between 2 channels.

Table 4: No. of one-way vs. two-way collaborations.

Type of Collaboration	Descriptions	No. of Videos	%
One way collaboration	Uploaded to main channel	84	71.19
Two ways collaboration	Uploaded to more than one channels	34	28.81
Total		118	

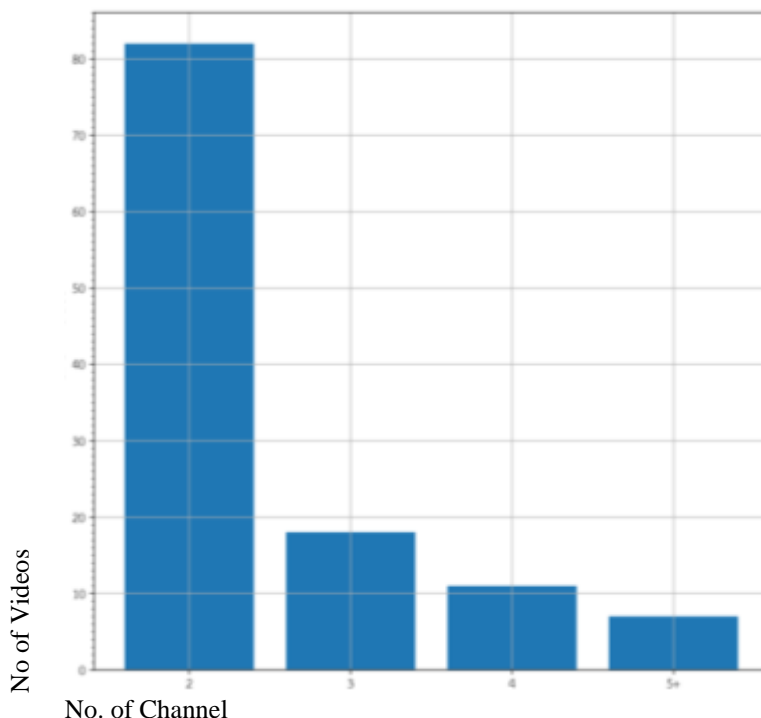


Figure 2: No. of channels appear in video.

Different Channel Level Collaboration

This study found that collaborations were mostly among celebrities and professionals (see figure 3 left). Professional channels collaborated in 57 videos and 20 videos for celebrity channels. Celebrity internally collaborated with professional channels for 28 videos, whereas professional channels seem more internally collaborated with celebrity (52 videos). Professional channels seem more open in collaboration with different channel types (see figure 3 right).

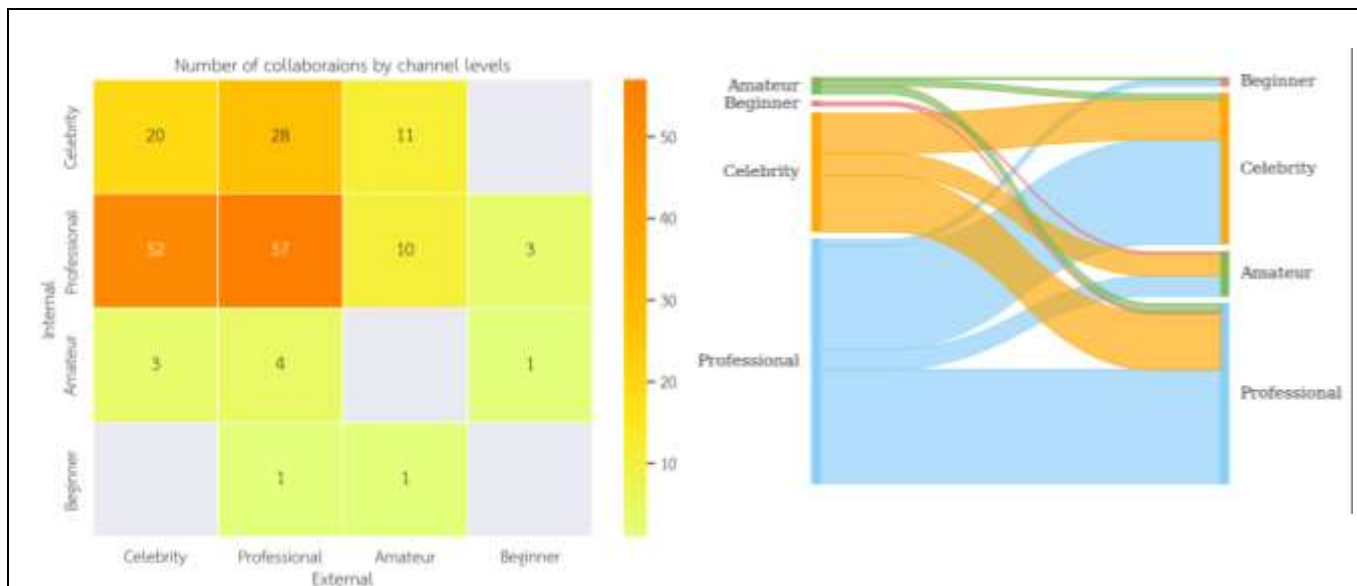
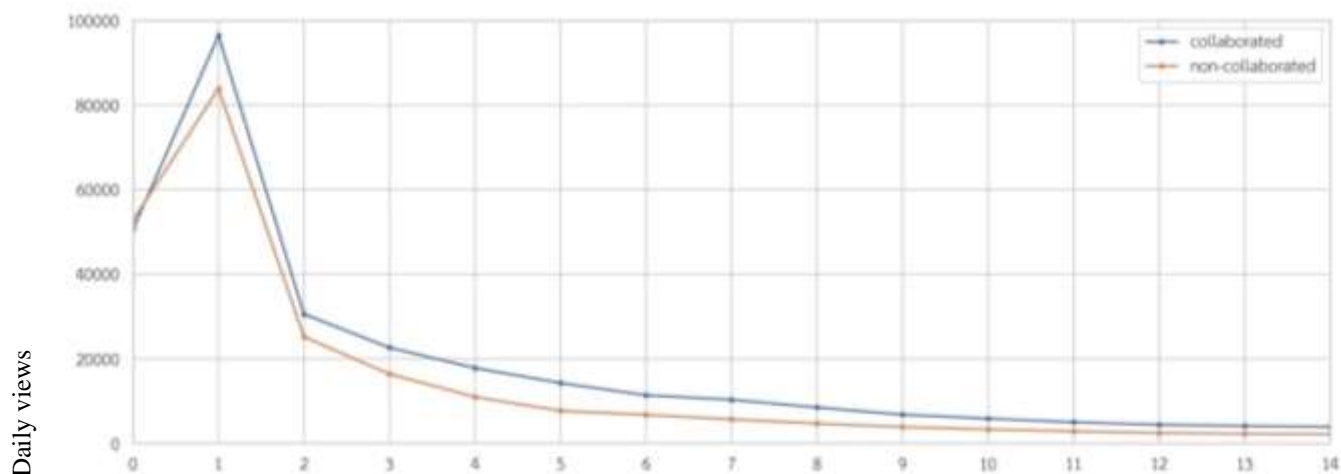


Figure 3: No of collaboration between different channel levels (left) vs. Ratio of collaboration between different channel level (right)

No. of Daily Views affected from Collaboration

The authors monitored no. of views daily for 14 days after each video was uploaded. Total 117 videos were included. The analysis showed that the number of daily views between collaborated and non-collaborated videos were radically different. The number of views from collaborated videos seem to higher according to figure 4. Statistically, t-Tested was used and the results indicated that two types of videos were significantly different (P=0.014) (see table 5). Figure 5 shows that celebrity channels have most view compared with professional and other channels.



Days after videos were uploaded
 Figure 4: Comparison between collaborate (blue) vs. non-collaborated (orange) videos according to no. of daily views

Table 5: t-Test on differences according to no. of views

Type of Collaboration	Collaborated Videos	Non-Collaborated Videos
Mean	22,824.98	15,428.86
Variance	709,343,886.9	531,51,643.9
Observations	15	15
Pearson Correlation	0.923620776	
Hypothesized Mean Difference	0	
df	14	
t Stat	2.774335145	
P(T<=t) one-tail	0.007457289	
t Critical one-tail	1.761310136	
P(T<=t) two-tail	0.014914579	
Critical two-tail	2.144786688	

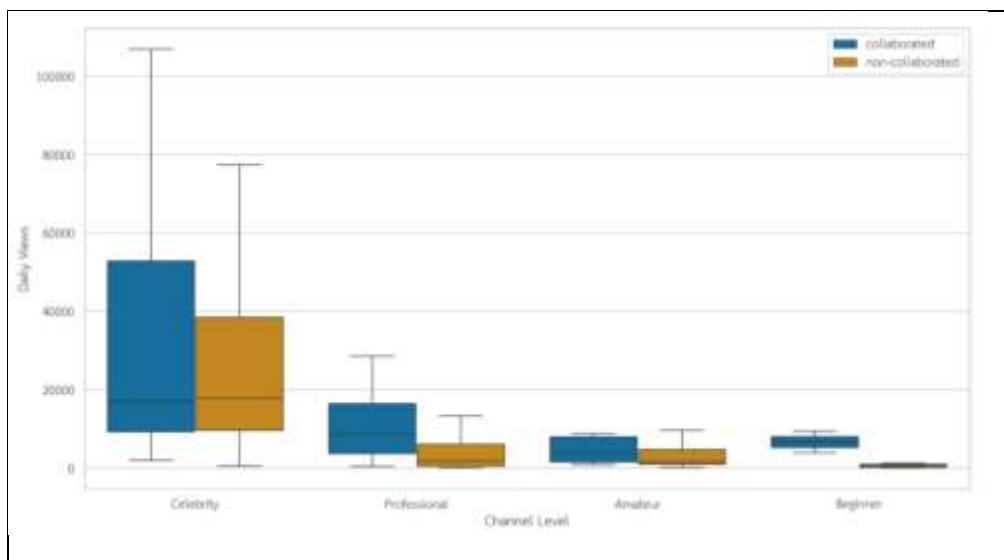


Figure 5: Comparison between collaborate (blue) vs. non-collaborated (orange) videos according to channel levels

No. of Daily Likes affected from Collaboration

The analysis showed that the number of daily views between collaborated and non-collaborated videos were radically different. The number of views from collaborated videos seem to higher according to figure 6. Statistically, t-Tested was used and the results indicated that two types of videos were significantly different (P=0.045) (see table 6). Figure 7 shows that celebrity channels have most view compared with professional and other channels.

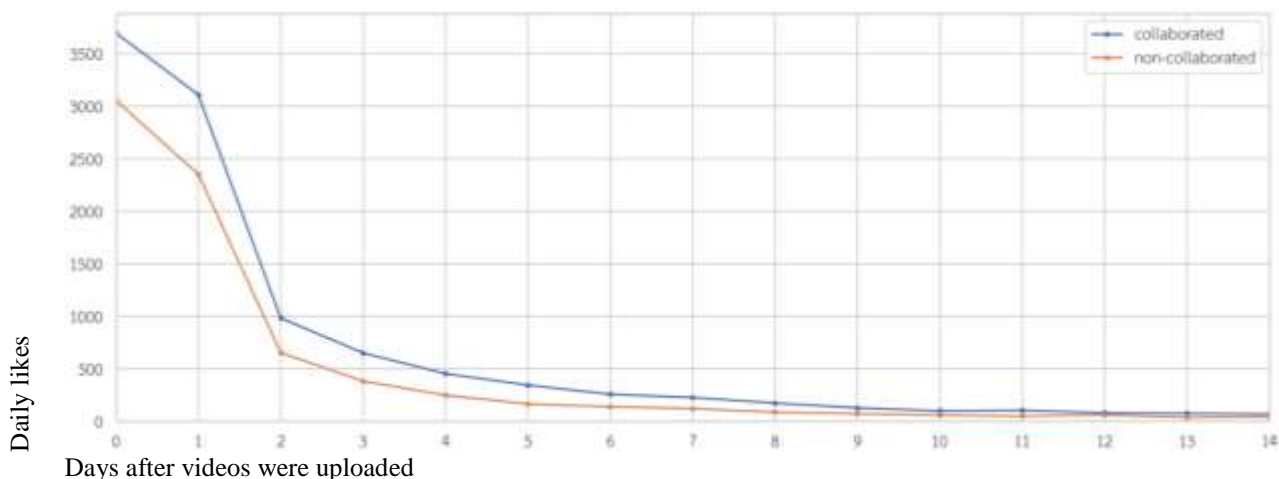


Figure 6: Comparison between collaborate (blue) vs. non-collaborated (orange) videos according to no. of daily likes

Table 6: t-Test on differences according to no. of likes

Type of Collaboration	Collaborated Videos	Non-Collaborated Videos
Mean	889.49	503.02
Variance	1650098.065	843526.3511
Observations	15	15
Pearson Correlation	0.859348534	
Hypothesized Mean Difference	0	
df	14	
t Stat	2.192882927	
P(T<=t) one-tail	0.022852856	
t Critical one-tail	1.761310136	
P(T<=t) two-tail	0.045705713	
Critical two-tail	2.144786688	

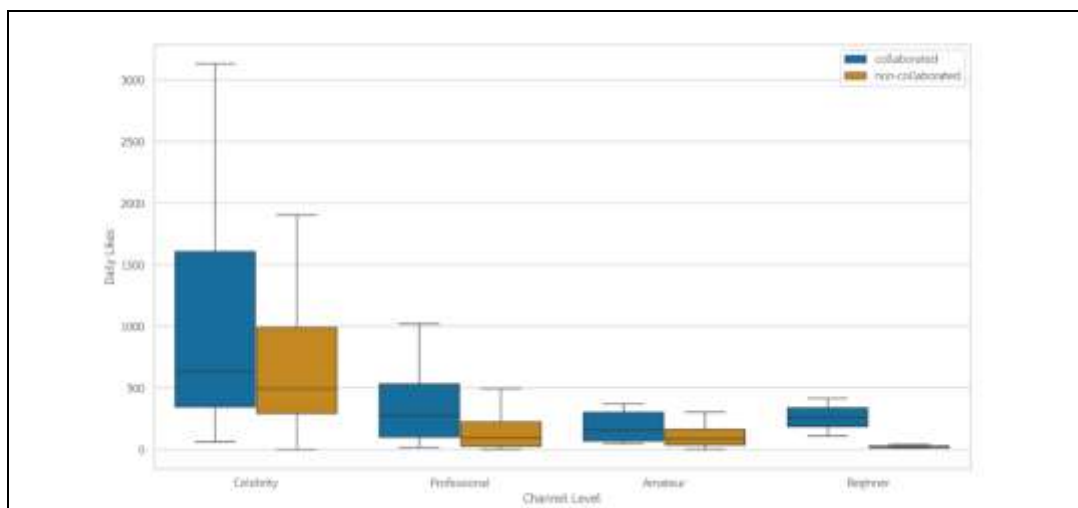


Figure 7: Comparison between collaborate (blue) vs. non-collaborated (orange) videos according to channel levels

Type of Videos and Channel Levels

The analysis shows that most collaborated videos were game show, talk show and challenge show accordingly (see table 7). However, only talk show and challenge show were statistically different from other shows (P=0.01, P=0.028) since the average views for both types of shows were lower than average. Variety show, vlog and game show had the highest average views accordingly. When compared with channel levels, game show was the most popular video type for both celebrity and professional channels. Challenge show was the second popular type of videos but only with professional channel. Celebrity channel aimed more on game show than other types of videos, whereas professional channel looked out for more varieties of video contents (see figure 8).

Table 7: No. of Videos according to types.

Type of Videos	No. of Videos	%	P-value	Average views for this type	Average view for other types
Challenge	17	14.41	0.010	8,862.62	21,419.32
Game show	42	35.59	0.807	22,058.28	23,098.55
Talk show	22	18.64	0.028	15,924.54	24,248.30
Variety show	12	10.17	0.115	52,401.90	19,183.93
Vlog	9	7.63	0.367	48,611.37	20,427.90
Others	16	13.56	0.012	10,933.22	24,604.16
Total	118	100			

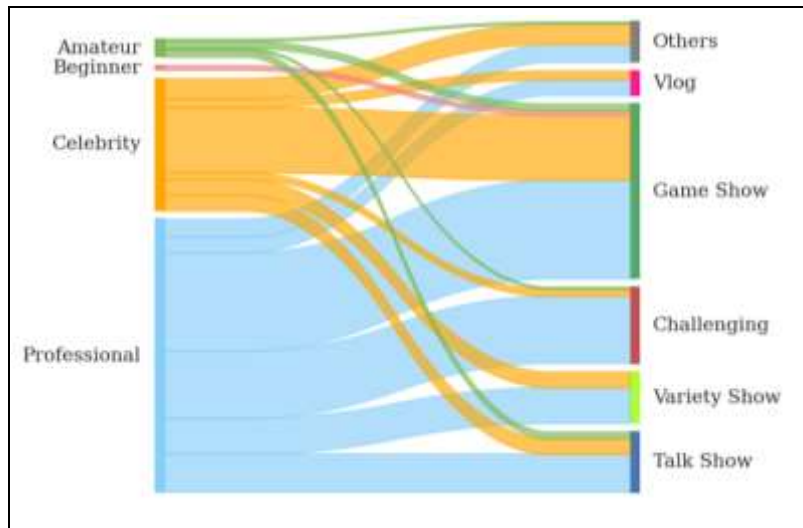


Figure 8: Ratio of video types vs. channel level

DISCUSSION AND CONCLUSION

Discussions

The observation data indicated that most collaboration were adopted by professional channels. Koch et al. (2018) mentioned two reason to support this phenomenon. First, the content style of professional channels normally provides supportive environment for collaboration i.e., same audience group, similar content style etc. Second, most professional channels mainly aim to gain number of their audiences. Therefore, collaboration is one of their strategies to achieve that goal. There is contrast results between this study and Koch et al. (2018). This study celebrity channel seems to collaborate more compared to amateur channel, whereas Koch et al. (2018) reported in the opposite result. The reason might be during the pandemic most celebrity channels were trying to gain their audience than normal period.

All results indicate in the same direction that collaboration gives significant effects to the number of audience engagement for YouTube channels. It simply because those channels not only exchanging their appearance between their channels and their exclusive channels. They are also exchanging their audience too. However, this research discloses preliminary underlying implication on how collaboration accelerates para-social relationship. To gain deeper understanding in this phenomenon, only no. of views and likes might not be sufficient. Further study might include analysis of comments on each video, which need to involve with more advance technology such natural language processing (NLP). Traditional method such as interview might also help revealing insights. Furthermore, the results from this study could be an input for developing of a framework for analyzing collaborative activities on digital platforms. To develop such a framework, design science research (Hevner et al., 2004) might be used as a theoretical paradigm.

Limitations

This study observed data only from sample channels, which were considerably small compared to the number of total channels available on YouTube platforms. The method to collect data was manual. It would be more effective if the authors will be able to collect data using programming bot. This mean a greater number of channels can be monitored and the period of monitoring will be longer. However, it will be more difficult to highlight specific external events, which might cause spike in numbers of view, likes and subscriptions. Moreover, collaboration is only one among 10 fundamental strategies to gain audience for youtubers, which other factors should be included for future studies. This research was also focused more on professional and celebrity channels whereas, many more amateur channels have been producing contents every day. In terms of generalizability, channels with variations of subscribers and views should be included in the analysis systematically. To achieve this, longer data collection period is mandatory with closed monitoring. The study might be expanded into longitudinal to be able to compare events across years.

Conclusions

This research concludes that in Thailand, collaboration among youtubers cause high effects on gaining number of audience engagement for youtuber. Exchanging appearances and audiences is more important than creating content alone. Moreover, digital video platform like YouTube, will gain more power among audiences since it is more effective in terms of on-demand watching and favor content creators more than traditional television programs. The acceleration of para-social relationship via collaboration was preliminary underlined. In practical, youtubers or content creators could see the benefits of collaboration. Therefore, further investigation and development to reveal insight of para-social relationship and other factors apart from collaboration should be considered.

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An economic analysis of software piracy in a competitive cloud computing market: A product bundling perspective

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ABSTRACT

In the cloud computing era, incumbent vendors are offering both on-premises software and cloud-based software service. Simultaneously, they are facing competition from new entries who just offer cloud-based software. However, piracy exists in on-premises software for incumbent vendors. Therefore, incumbent vendors are facing pressure from piracy and new entries at the same time. Using the framework of product bundling, this study builds a stylized analytical model to investigate the optimal product bundling strategies for software vendors in the presence of software piracy. The research found that the pure bundling strategy is the best choice for existing software vendors in the market in most cases because of the more flexible bundling price. Pure component strategy can be more profitable than pure bundling strategy when piracy costs are at the medium level.

Keywords: Software piracy, cloud computing, product bundling, market competition.

INTRODUCTION

Piracy has always been a significant obstacle to the software industry's healthy development (BSA, 2018). As Internet technology has developed, it has facilitated the transmission of information, but also exacerbated software piracy. Piracy severely infringes on developers' intellectual property, reduces the living space of licensed software, and has a negative impact on the development of future technologies. Product price is usually considered the main reason for users to choose software piracy. Therefore, vendors should fight against piracy by adopting appropriate pricing strategies.

Cloud computing is being considered another way to combat software piracy. By applying cloud computing technology, software vendors can not only regulate authentication and monitor customer usage but also limit access to reduce piracy (Wang, 2017). As a result, cloud computing has progressively become the primary focus of software vendors' development efforts. However, transferring traditional software vendors to cloud service is a lengthy and hazardous process. While traditional software vendors pay a higher setup fee than cloud software vendors, they charge on a demand or usage basis (Intellias, 2021). Due to the scale effect, traditional software vendors will not be able to easily abandon traditional software sales. At the same time, new cloud software competitors are entering the market. They usually only offer cloud computing services.

Simultaneously facing pressures of piracy in on-premises software channels and pressures of competition from new entries, incumbent vendors need to make decisions on whether to sell on-premises software and cloud-based software service individually, which is the Pure Component (PC) strategy or sell them together in a package, which is Pure Bundling (PB) strategy (Riordan *et al.*, 2012). By building a stylized analytical model, this research uses a numerical method to investigate the optimal bundling strategies for software vendors under various market conditions.

In most circumstances, it is discovered that the PB outperforms the PC. The profit under PC may exceed PB when Vendor ¹ set a proper restriction on piracy. This article examines the ideal software bundling method in competitive markets, taking cloud computing functions and piracy into account. The scenario examined in this study is more representative of the current state of the software market and gives practical sales methods for software vendors in an era of coexistence of traditional and cloud computing software.

LITERATURE REVIEWS

Product Bundling

Product bundling has been widely examined in information systems and other fields. (Derdenger & Kumar, 2013) had investigated the bundling strategy of software and hardware. Bakos and Brynjolfsson (1999) studied the bundling of information, commodities and pointed out that the bundling strategy of information commodities was different from that of

traditional commodities because the marginal replication cost of information commodities was almost zero. Venkatesh and Kamakura found that marginal cost and complementarity among products would influence the optimal bundling strategy (Venkatesh & Kamakura, 2003). Pang and Etzion (2012) studied the bundling of products and online software components. Gopal and Gupta (2010) showed that manufacturers use bundling to combat the sharing clubs, and point out that product bundling can always add up to consumer surplus. In the recent research, researchers focus on the effect when adopting bundling strategy in different aspects. Honhon and Pan (2017) analyze a firm that sells vertically differentiated components and the impact of adopting different bundling strategies. Shivendu and Zhang (2019) focused on the analysis of a publisher who offers information goods in physical and digital mediums and also these two goods in a bundle. Some researchers studied the problem of software bundling in the era of cloud computing and considered the effect of piracy (Zhang & Yue, 2020; Zhang et al., 2019a, 2020). Dey et al. (2021) focused on the free support forums effect on the software vendor and the software vendor's pricing strategy. Following the literature, this paper studies the problem of software bundling in the era of cloud computing. At the same time, this study introduces the competition between vendors of cloud computing and on-premises software, and more importantly, considers the impact of software piracy.

Software Piracy

Kim et al. (2018) found that a moderate level of piracy has a positive impact on the profits of the manufacturer and a high surplus for consumers. Kim et al. (2022) showed that high quality of the illegal copy associated with low quality development costs, which means it is optimal to eliminate piracy when the quality development cost is high. Zhang et al. (2021) found that the intensity of market competition plays a critical role in the decisions on anti-counterfeit efforts. When market competition is less intense, there is a greater economic incentive to combat counterfeit selling. Some studies found that piracy may be used to prevent the entry of the entrants and found that accommodating piracy will be a better choice for some software vendors to maximize profits. Piracy acts instead as a deterrent to entrants (Nie et al., 2022). Some studies also found that the existence of software piracy also leads to a greater surplus for the users (Zhang et al., 2018). Some studies have explored the relationship between software quality and software piracy and found that the existence of pirated software to a certain extent will also encourage software suppliers to provide higher quality software (Lahiri & Dey, 2013). Zhang and Yue (2013) focus on fighting against software piracy, they found that the bundling of software applications could be a way to minimize the negative impact of software piracy. Machado et al. (2017) showed that firms may make more effort to control piracy when network externalities are strong. The sellers will try to maintain a large perceived quality gap between the product and piracy product.

Distinction From Existing Literature

Our study analyzes software piracy in the era of cloud computing. Especially in the case of market competition, from the Angle of commodity bundling analysis.

MODEL

Our study considers the market competition between two profit-maximizing vendors. Vendor I provides a software as a product and a software as a service (Products 1 and Product 2). Vendor I could choose one of the following two selling strategies: (1) sells products separately, which is a pure component, or PC, (2) sells both products in a software bundle, which is pure bundling, or PB. Vendor E provides only cloud-based software services (Product E) that offer similar functionality as Product 2 from Vendor I .

The consumer is heterogeneous. For Product 1 and Product 2, we regard r_1, r_2 as respective reserving utilities which follow a uniformly joint probability density distribution normalized to the range of 0 and 1, i.e., $(r_1, r_2) \in [0,1] \times [0,1]$. For Product E , between r_E and r_2 , there is a proportion β , we assume that $r_E = \beta r_2$, with $\beta \in [0,1]$ to ensure the quality of Product E is inferior to that of Product 2.

Software products and cloud services may complement or substitute each other. We use α to denote the complementarity between software product and service. The utility of simultaneously using both software product and service would be $r_{12} = (1 + \alpha)(r_1 + r_2)$, with $0 \leq \alpha < 1$. When purchasing product 1 and product 2 at the same time, consumers obtain not only the individual utility of the two products, but also the additional utility through the complementary effect. It is worth mentioning that since pirated software and Product E cannot coordinate online and offline through a unified account, it is assumed that the complementary level exists only between Product 1 and Product 2.

Vendor I sets prices of p_1 (p_2 or p_b) for Product 1 (Product 2 or bundle). Vendor E sets the price of p_E for Product E. On the other hand, Vendor I and Vendor E incur fixed costs c and βc for each service user, such as computing, storage, runtime management, etc. Table 1 presents the selling options and associated utilities in each selling strategy.

Piracy exists in the software industry. Vendors often use DRM to manage piracy. When consumers choose to use pirated software, they need to face a particular piracy cost t . This cost can be understood as the searching cost, the fee paid for pirated software, or the possible fine or loss once discovered. In addition, we assume that the piracy cost is the same under PC and PB.

Table 1: Purchase Options and Utility

Strategy	Options	Purchase Options	Utility
PC	o_1	None	0
	o_2	Product 2	$r_2 - p_2$
	o_3	Product 1 and Product 2	$(1 + \alpha)(r_1 + r_2) - p_1 - p_2$
	o_4	Pirated Product 1	$r_1 - t$
	o_5	Pirated Product 1 and Product 2	$r_1 + r_2 - t - p_2$
	o_6	Product E	$r_1 + r_2 - t - p_e$
	o_7	Pirated Product 1 and Product E	$r_1 + r_e - t - p_e$
PB	o_1	None	0
	o_2	Bundle	$(1 + \alpha)(r_1 + r_2) - p_b$
	o_3	Pirated Product 1	$r_1 - t$
	o_4	Product E	$r_e - p_e$
	o_5	Pirated Product 1 and Product E	$r_1 + r_e - t - p_e$

When buying both Product 1 and Product 2, consumers can obtain the utility of $(1 + \alpha)(r_1 + r_2) - p_1 - p_2$ in PC or $(1 + \alpha)(r_1 + r_2) - p_b$ in PB. However, when a consumer buys Product 2 and uses pirated Product 1, the utility is $r_1 + r_2 - t - p_2$. When a consumer buys Product E and uses pirated Product 1, the utility is $r_1 + r_e - t - p_e$. Consumer evaluates the net utility from each purchase option to choose the option leading to the highest utility. For example, if the utility consumer got from piracy is higher than the utility got from purchasing Product 1, i.e., $r_1 - t > r_1 - p_1$, in other words, $t < p_1$, consumers will be inclined to pirate products.

Figure 1 shows market segmentation in PC and PB, with scenarios derived from specific parameter values, including price and piracy costs. In Figure 1, there are 7 consumer groups, each buying one purchase option in PC and PB (see Table 1).

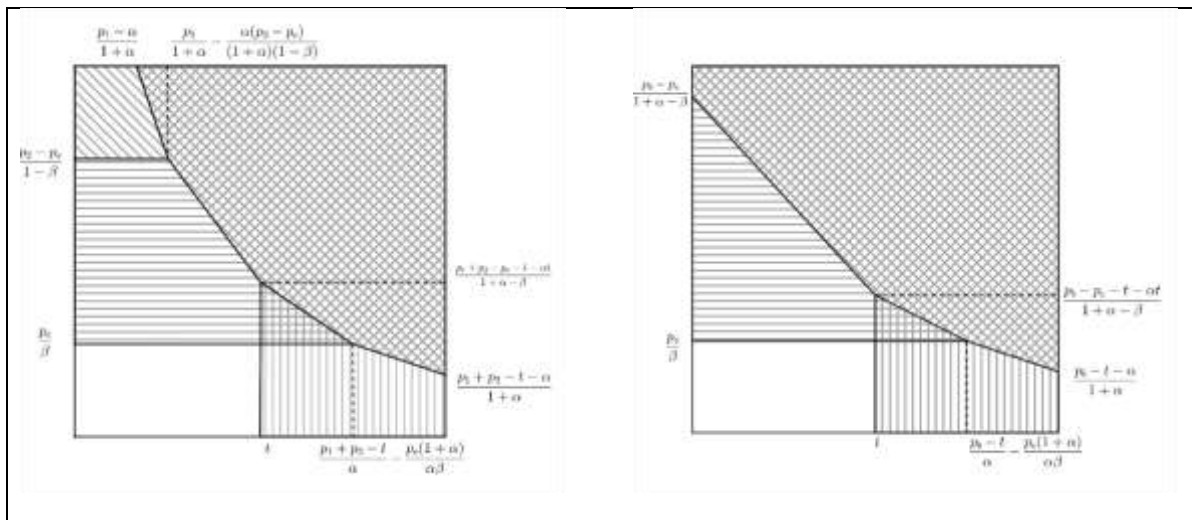


Figure 1: Market Segmentation of PC and PB

ANALYSIS

In product bundling in the presence of market competition, it is difficult to obtain analytical solutions. Numerical simulation methods will be used in this context. The research uses numerical analysis and set up several combinations of parameters. Research finally obtained the price strategies and the corresponding profit changes for Vendor E and Vendor I under PC and PB strategies respectively. The results are as follows:

Observation 1: In PC,

- (1) When piracy cost t increases, p_2 and p_e remain stable and p_1 increases;
- (2) As the service utility ratio β increases, p_2 and p_e remain stable and p_1 decreases;
- (3) As the complementary level α increases, p_2 and p_e remain stable and p_1 increases.

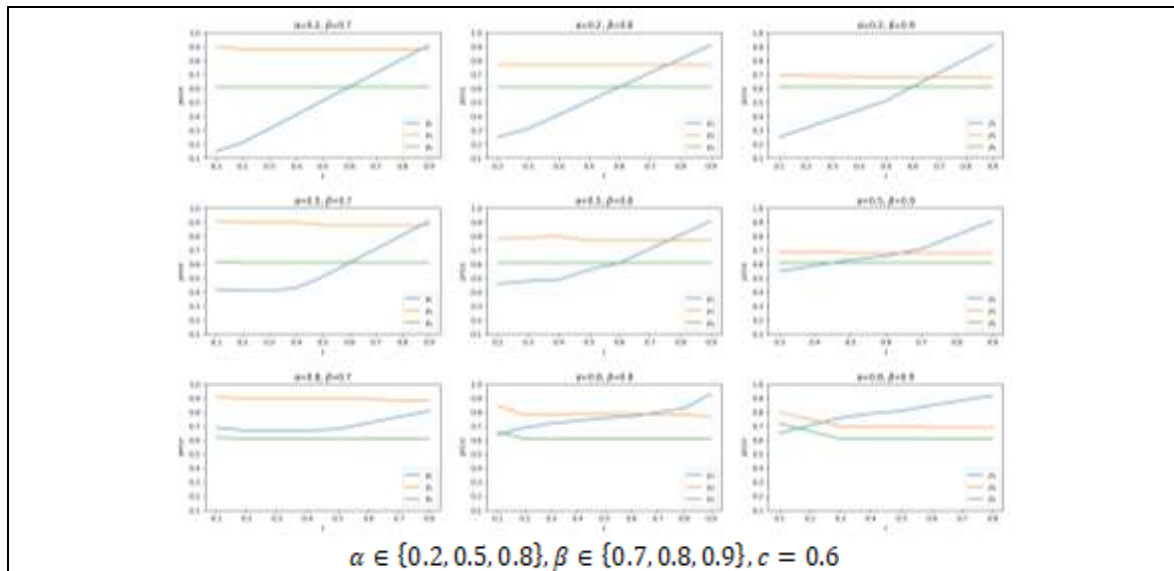


Figure 2: Price Comparison in PC

As t increases, consumers' utility from piracy decreases. Compared to pirated Product 1, consumers are more willing to buy licensed Product 1. As the demand for Product 1 increases, Vendor I is able to make higher profits from consumers by increasing prices, so P_1 tends to increase. P_2 and P_3 prices remain stable because they are not affected by piracy. As β increases, Vendor E becomes more competitive and Vendor I chooses to lower price to maintain advantage and attract more consumers in the competition. This price reduction strategy results in Vendor I 's utility always being higher than Vendor E . When α increases, consumers will get higher utility from purchasing bundling products. Therefore, Vendor I will choose to raise prices to obtain higher profits, P_1 increases with an increase in α .

When analyzing PB strategy, we find:

Observation 2: In PB,

- (1) As the cost of piracy t increases, P_E remains stable;
- (2) As the service utility ratio β increases, both P_E and P_B remain stable;
- (3) As the complementary level α increases, P_E remains stable and P_B has a small increase.

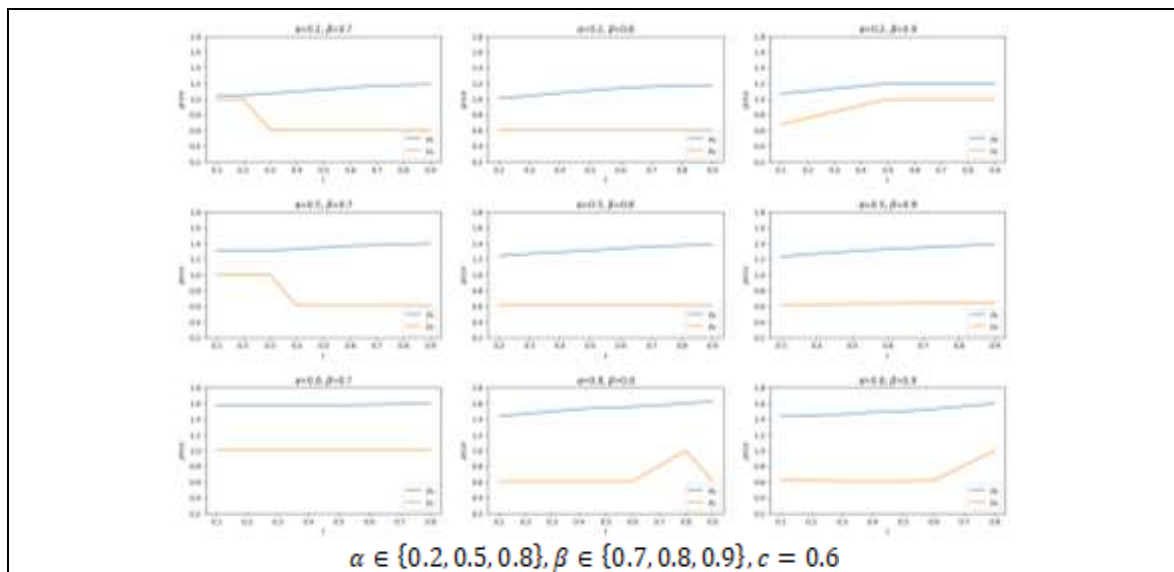


Figure 3: Price Comparison in PB

When t increases, P_E remains stable because it is not affected by piracy. In Figure 3, P_B is always higher than P_E . When Vendor I chooses PB, it can always maintain a dominant position in the market and make higher profits. Because of Product E 's lower utility, Vendor E can only earn a small profit from the market by pricing almost at cost. As α increases, bundling

becomes more attractive to consumers, and consumers' demand for bundling products increases. Therefore, Vendor I chooses to raise prices to earn higher profits.

When analyzing profits under both strategies, we find:

Observation 3:

- (1) As the cost of piracy t increases, profits under PB and PC increase;
- (2) As the complementarity level α increases, the profits under PB and PC increase;
- (3) As the utility ratio β increases, the profit under PB remains stable, and the profit under PC increases.

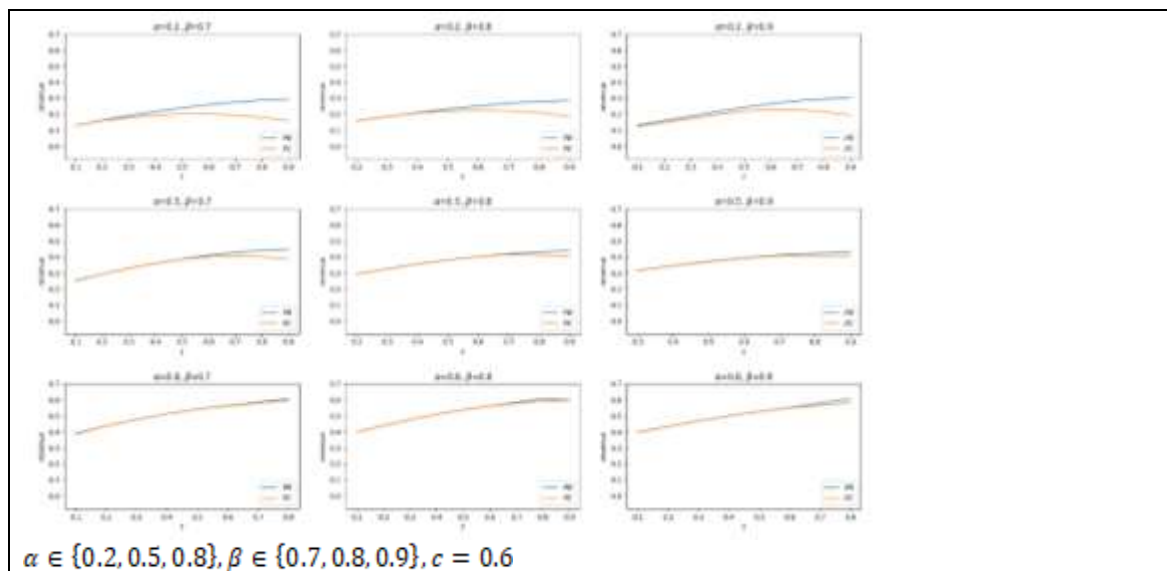


Figure 4: Revenue Comparison (PB vs PC)

As t increases, the profit of Vendor I under PB rises. This is because in PB, the only product combination of Vendor I is bundling, which is easier to maintain high user utility. However, PC products combination also includes services that are sold individually, which competes more fiercely with the newly added vendor E service. Compared to PB, vendor E service is able to gain more market share under PC. The increase of t also means that Vendor I pays more on DRM cost, thus increasing the price of Product 1. In more situations, the services become the choice with the highest utility for Vendor I . When Product E 's utility exceeds services' utility, Vendor E will be more competitive. Thus, as t increases, the gap between PB and PC grows. As α increases, bundling under PC has the highest utility. For Product E , it's hard to have higher utility than bundling product. Therefore, Vendor I profits under PC increase and become closer to PB. The increased complementarity also increases the total profitability of Vendor I under both strategies. When β is increased, Product E 's utility increases, but the cost increase either. With parameters shown in Table 4, there is a small increase in Vendor I profit under the PC strategy as beta increases.

Observation 4:

When t is in the middle, Vendor I may obtain higher profit under PC than under PB; Otherwise, Vendor I obtain higher profit under PB than under PC.

When t is in the middle, it's more profitable for Vendor I to choose PC. When t is large or small, it's more profitable for Vendor I to choose PB. When t is in the middle, piracy level is also in the middle. Vendor I choose PC strategy to sell software product and service separately to curb piracy. When t is small, the cost of piracy is low, piracy is more rampant. Vendor I choose PB strategy to sell software product and service as a bundle instead of selling them separately. When t is large, the cost of piracy is high, price of software product is also high. Vendor I choose PB.

CONCLUSION

This study focuses on the current landscape of software industry by paying attention to the software piracy problem in a competitive market. We investigate the optimal piracy curbing strategy in the cloud computing era using a product bundling framework. We use both analytical modeling and numerical simulation methods to observe the effects of complementarity, piracy costs, software service infrastructure costs, and other factors. We find that in most cases PB is the better strategy for the

incumbent vendor because it could set a lower bundle price, thus users could get higher utility, and eventually attracts more users to buy. PC is better than PB only when the cost of piracy is in the middle range. Because more users tend to choose piracy product when the cost of piracy is low, and when the cost of piracy is high the cost of fighting piracy is high. These two reasons lead to a decrease in total profit.

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APPENDIX

Before pure cloud service provider Vendor E enter the market, the whole market was dominated by the incumbent Vendor I . In this case, there are seven different cases for PC and three different cases for PB (Zhang et al., 2019b). Now when vendor E enters, several sub-cases would occur depending on the value of various parameters.

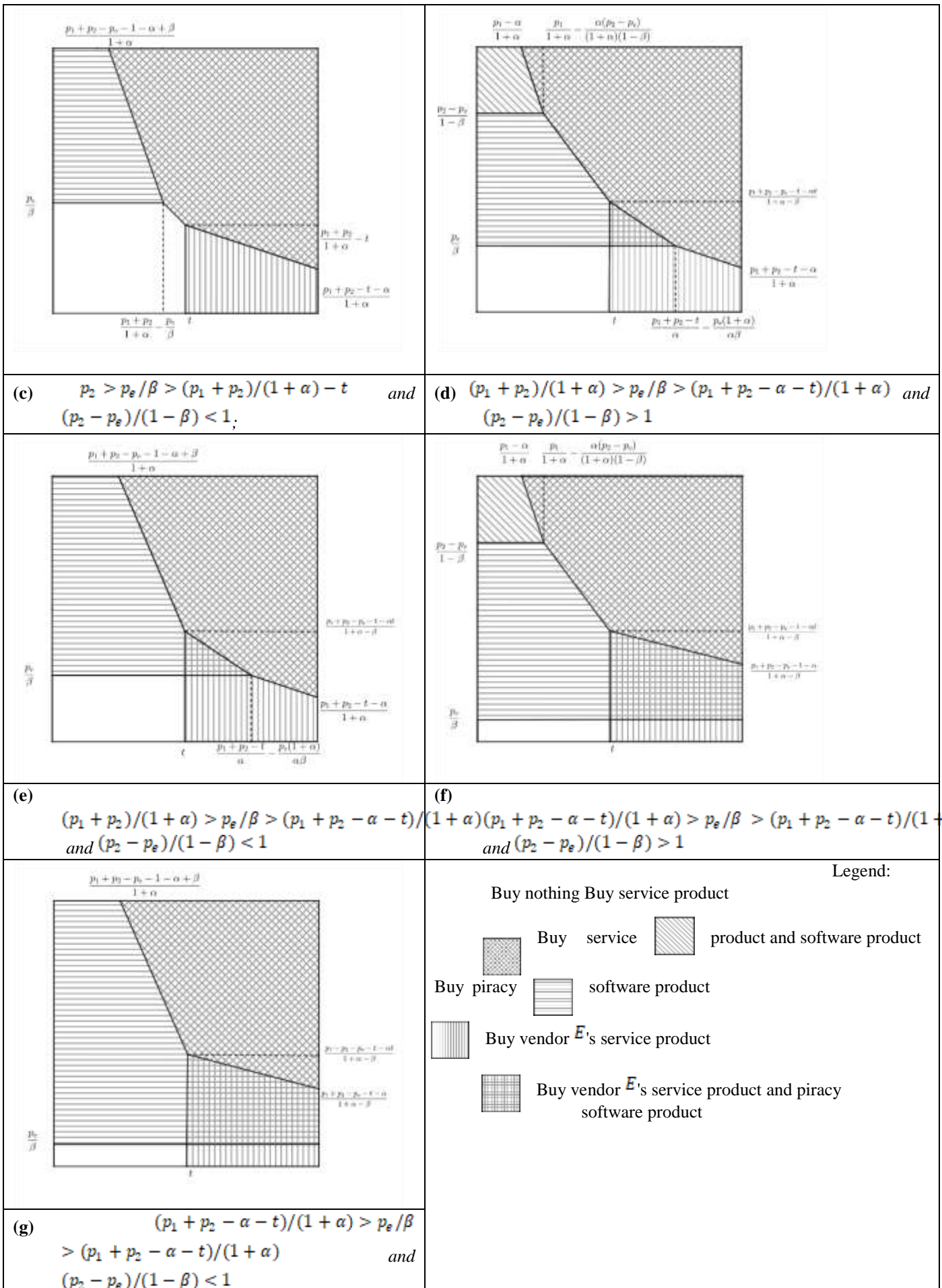
For PC, when $(p_1 - \alpha)/(1 + \alpha) > 0$ and $(p_1 + p_2 - t - \alpha)/(1 + \alpha) > 0$, there are 7 sub-cases; When $(p_1 - \alpha)/(1 + \alpha) < 0$ and $(p_1 + p_2 - t - \alpha)/(1 + \alpha) > 0$, there are 9 sub-cases; When $p_2 > (p_1 - \alpha)/(1 + \alpha)$ and $(p_1 + p_2 - t - \alpha)/(1 + \alpha) > 0$, there are 4 sub-cases; When $(p_1 - \alpha)/(1 + \alpha) > 1$ and $(p_1 + p_2 - t - \alpha)/(1 + \alpha) > 0$, there are 4 sub-cases; When $(p_1 - \alpha)/(1 + \alpha) < 0$ and $(p_1 + p_2 - t - \alpha)/(1 + \alpha) < 0$, there are 4 sub-cases; When $p_2 > (p_1 - \alpha)/(1 + \alpha)$ and $(p_1 + p_2 - t - \alpha)/(1 + \alpha) < 0$, there are 3 sub-cases; When $(p_1 - \alpha)/(1 + \alpha) < 0$ and $(p_1 + p_2)/(1 + \alpha) - t < 0$, there are 3 sub-cases;

For PB, When $p_b/(1 + \alpha) > 1$, there are 4 sub-cases; When $p_b/(1 + \alpha) < 1$ and $(p_b - t - \alpha)/(1 + \alpha) > 0$, there are 7 sub-cases; When $p_b/(1 + \alpha) < 0$, there are 5 sub-cases;

Due to page limitation, we only present two representative cases, PC when $(p_1 - \alpha)/(1 + \alpha) > 0$ and $(p_1 + p_2 - t - \alpha)/(1 + \alpha) > 0$, and PB when $p_b/(1 + \alpha) < 1$ and $(p_b - t - \alpha)/(1 + \alpha) > 0$. Analysis of other sub cases are available upon request.

Table A1: Indifference curves for different models for PC

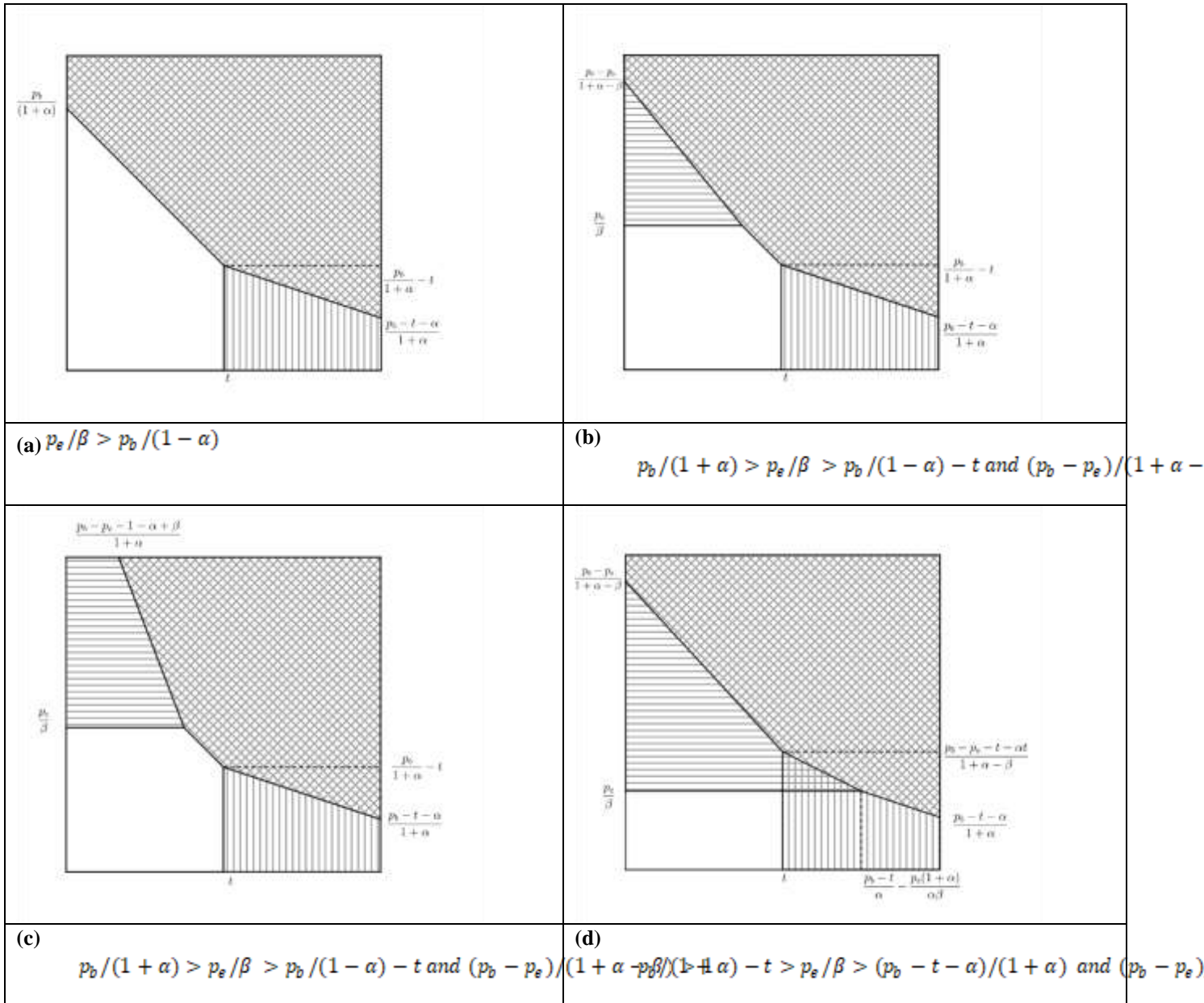
<p>(a) $p_e/\beta > p_2$</p>	<p>(b) $p_2 > p_e/\beta > (p_1 + p_2)/(1 + \alpha) - t$ and $(p_2 - p_e)/(1 - \beta) > 1$</p>

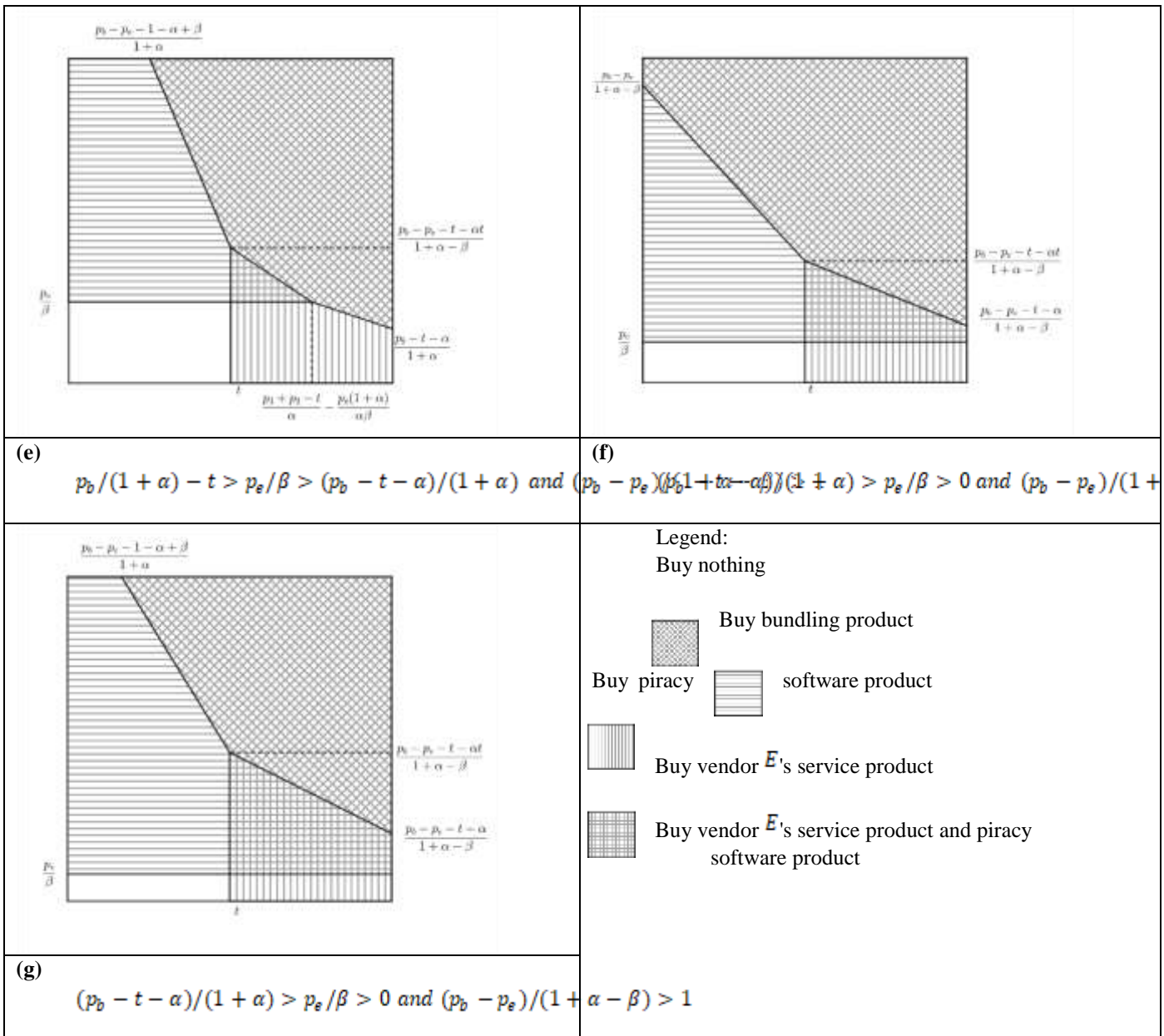


Notes:

	$p_e/\beta > p_2$	$p_2 > p_e/\beta > (p_1 + p_2)/(1 + \alpha) - t$	$(p_1 + p_2)/(1 + \alpha) > p_e/\beta > (p_1 + p_2 - \alpha - t)/(1 + \alpha)$	$(p_1 + p_2 - \alpha - t)/(1 + \alpha) > p_e/\beta$
$(p_2 - p_e)/(1 - \beta) > 1$	(a)	(b)	(d)	(f)
$(p_2 - p_e)/(1 - \beta) < 1$		(c)	(e)	(g)

Table A2: Indifference curves for different models for PB





Notes:

	$p_e/\beta > p_b/(1 + \alpha)$	$p_b/(1 + \alpha) > p_e/\beta > p_b/(1 - \alpha) - t$	$p_b/(1 + \alpha) - t > p_e/\beta > (p_b - t - \alpha)/(1 + \alpha)$	$(p_b - t - \alpha)/(1 + \alpha) > p_e/\beta > 0$
$\frac{p_b - p_e}{1 + \alpha - \beta} < 1$	(a)	(b)	(d)	(f)
$\frac{p_b - p_e}{1 + \alpha - \beta} > 1$		(c)	(e)	(g)

Competence recharging in the pandemic: The role of social support, motivation, organizational culture, and self-awareness

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ABSTRACT

Using Smart PLS, this study analyzed the four primary criteria for recharging competence during a pandemic: social support, motivation, corporate culture, and self-awareness. Principally, the researcher employs a structural model to test these hypotheses. This study surveyed 105 employees with at least two years of competency or skill certification in Indonesia. Researchers examined the effects of organizational culture constructs on motivation, self-awareness, and social culture. The findings revealed that just one construct was significantly related to the three variables, notably result oriented. In particular, innovation and risk-taker ($\beta=0.162$; $p<0.05$), result-oriented ($\beta=0.403$; $p<0.01$), and team-oriented ($\beta=0.235$; $p<0.05$) are significant to self-awareness. Then only a result-oriented is relevant to motivation ($\beta=0.524$; $p>0.05$) and social support ($\beta=0.434$; $p>0.01$). The results of the model suggested that motivation, social support, and self-awareness can account for 67.2% of competence recharging. All of the model's path coefficients are given and explained. Social support has no significance on recharging competence ($\beta=0.080$; $p>0.05$). In addition, motivation has significant and favorable benefits on recharging competence ($\beta=0.380$; $p<0.05$). Self-awareness of recharging competence is also statistically significant ($\beta=0.414$; $p<0.05$). Based on the results, a company should examine these concepts to increase employee motivation and self-awareness, which influences the recharging of skills.

Keywords: Competence recharging, motivation, organizational culture, self-awareness, social support.

INTRODUCTION

The COVID-19 pandemic is causing career and workplace issues owing to difficult circumstances such as working from home (Bick et al., 2021), employment termination (ILO, 2020), personal well-being (Tul et al., 2021), and the company's transformation (Schindlwick, 2021). Work-from-home policy pertaining to the company's transformation, including all human resources procedures. The epidemic shifts recruitment from offline to enormous online applications and training from in-person to digital. People must be informed and regulated to establish the optimal self-development strategy (Atmojo et al., 2020).

One of the human resources problems of the COVID-19 pandemic is the management of abilities such as leadership (Dirani et al., 2020), critical thinking, and problem-solving skills (Fitarahmawati & Suhartini, 2021). Managing competency was simple before the epidemic, but human resource professionals must now adopt a new mindset owing to constantly changing circumstances. The epidemic necessitates a learning strategy that facilitates employee self-development and can be implemented remotely. Before the emergence of COVID-19, businesses blend online and offline learning to develop their employees' skills. Distance learning now dominates all industries, with 61.7% utilizing video conferencing capabilities and 56.5% utilizing other online learning resources (ILO, 2021). In addition, working from home necessitates enhanced management and leadership to encourage employee engagement (Muttaqin et al., 2020).

In addition to training methods, employees desire new topics or skills for their professional development (Mikoajczyk, 2021). In Indonesia, 86 percent of businesses concur that pandemic and lockdown rules provide a fresh viewpoint on "unsupervised" work arrangements. Therefore, 74% aim to focus on upskilling or reskilling their staff (Mercer, 2021). The key to bridging the gap between unpredictable situations and staff productivity is maintaining or enhancing employee competencies (ILO & World Bank, 2021; Nuys, 2021).

The Indonesian government's vision for 2045 prioritizes the equitable deployment of high-quality human resources. This vision is titled "Superior Human Resources, Advanced Indonesia" and places a premium on mastery of skills and knowledge, particularly in science and technology (Indonesia Ministry of Education and Culture, 2017). One of the government's goals for

advancing the Indonesian people is the promotion of competency and skill. In addition, enhancing abilities or competencies assists Indonesians in joining the worldwide competition and bolsters their recuperation from Covid-19 (OECD, 2021).

Following the goal of the Indonesian government for 2045, this study investigated the psychological elements that influence a person's ability to keep competence. This study employs psychological variables of social support, motivation, organizational behavior, and self-awareness. Based on these variables, the following research questions are posed: What roles do social support, motivation, organizational behavior, and self-awareness play in the recharging of competence? According to the objectives of the Indonesian government, this study includes numerous contributions. This study contributes to the existing knowledge regarding the recharge of competencies in the workplace throughout this epidemic. Our research focuses not on the sort of competency but on the psychological aspects that influence people's desire to recharge their skills.

Organizational Culture (OC)

Organizational culture refers to the culture accepted as a habit collectively understood and utilized as a guide for members' actions and interactions. Langton, Robbins, and Judge (2013) define organizational culture as a meaningful system shared by individuals that distinguish the organization from others. Corporate culture trains its members on how to behave within the organization (Immanuel & Mas'ud, 2017). A company with a positive culture will inspire its people to achieve at their highest level.

Some elements of organizational culture include (1) innovation and risk-taking; it is a business incentive to encourage employees to take risks and innovate at work; (2) attention to detail. Every profession requires accuracy, analysis, and attention to detail; (3) focusing on results. Management focuses on the consequences of work rather than the procedures and strategies utilized; (4) human resource orientation illustrates how management policies impact organization members; (5) team orientation, or the extent to which work activities are accomplished as a group as opposed to independently. (6) aggressiveness, or the degree to which members of the organization are competitive and aggressive in their approach to work results; (7) stability, or the capacity of organizational activities to sustain growth; and (8) flexibility, or the ability of organizational activities to adapt to changing circumstances (Langton, Robbins, & Judge, 2013).

The rationale of the company's founder guides the formation of its culture, which influences its recruitment standards as the organization grows. Various senior management policies also influence an organization's corporate culture. New employees can be introduced to culture through narratives, traditions, symbols, and language.

Motivation (M)

When discussing employee performance, "motivation" is commonly mentioned. This motivation is one of the most significant predictors of a person's professional success. Maslow, McGregor, McClelland, and Herzberg are experts who have contributed to the development of the theory of motivation. The Two-Factor Theory by Herzberg is a well-known motivational theory (Robbins, 2007). According to this view, workers are driven by what makes them happy (satisfaction) and miserable (dissatisfaction).

There are two sorts of work motivation: intrinsic and extrinsic. Work motivation includes all forms of intrinsic encouragement that are unaffected by the social environment or external conditions. Personal learning objectives are examples of this intrinsic motivation (Aprieliava et al., 2021). On the other hand, extrinsic motivation is strongly dependent on employees' external situations. Social conditions, superior response, salary, and acceptance by subordinates are examples of extrinsic motivation in employees. Extrinsically motivated employees will be very reliant on their surroundings. Three types of wants can inspire individuals to act, according to Deci, Connell, and Ryan (1989): (1) the need for independence/autonomy, (2) the need for competence, and (3) the need for interrelationships.

Self-awareness (SA)

Self-aware employees comprehend their competency potential and can independently evaluate the efficacy of their work. Moreover, self-awareness supports employees in understanding the correct method of self-development and can keep their future items. Self-awareness permits employees to perform more efficiently when complemented by favorable social connections. It is easier for employees to engage in and pursue competency development. Employees develop internal motivation, satisfy the objectives of their superiors, and function socially (Kreibich et al., 2020).

There are multiple sorts of self-awareness: (1) objective self-awareness is the comprehension of the factors that distinguish the individual from the social environment. Those with objective self-awareness are able to recognize their potential, whereas others are unable to. This type aids individuals in seizing chances and competing to achieve their objectives; (2) subjective self-awareness leads to internal conditions. (3) symbolic self-awareness refers to the ability to form abstract concepts and communicate or convey something through language; (1) process self-awareness refers to the ability to comprehend the process of daily life that is lived, to remember what is required, and to know one's function as a human being; (2) functional self-awareness refers to an individual's understanding of the process of People utilize self-awareness when forming deep relationships with others. Individuals will create a speech pattern or communication style that others accept (Kreibich et al., 2020).

Social Support (SS)

Individuals view social support as significant when it is characterized as a form of care and protection supplied by others (Langford et al., 1997; Bakker & Demerouti, 2017). Social assistance might assist employees in coping with job responsibilities (Bakker & Demerouti, 2017). Individuals' social networks can receive social support from superiors, co-workers, or subordinates at work and family members, including spouses, children, and siblings (Quick & Quick, 1984). Coworkers and family members provide physical and psychological comfort through social support at work (Baron & Byrne, 2000). Seniors also play a role in offering social assistance to their members to help employees deal with job issues (Jia & Shoham, 2012). Employees who perceive insufficient social support report greater job satisfaction and engagement (Orgambdez-Ramos & de Almeida, 2017).

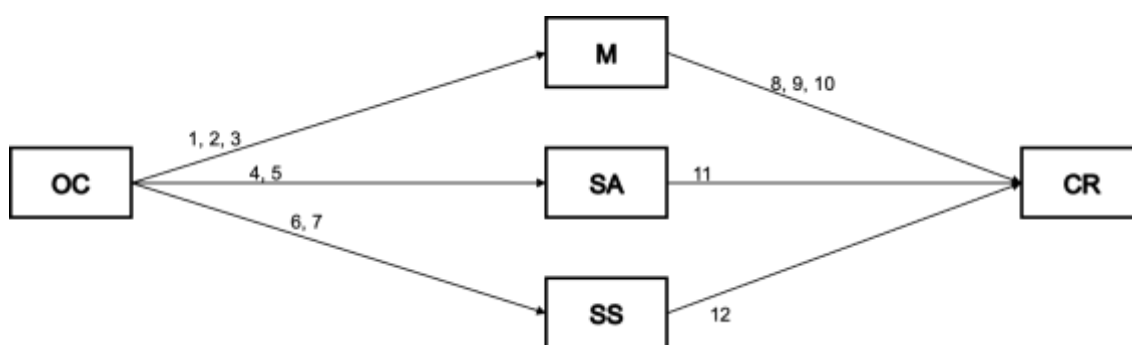
Multiple theories support social support. (1) The social comparison hypothesis. According to social comparison theory, humans are essentially driven to compare their talents with those of others (Cohen & Syme, 1985). Social comparison becomes crucial in developing self-concept, coping skills, emotional adjustment, self-esteem, and psychological health (Langford et al., 1997). Social comparison can help individuals view themselves more favorably and strengthen their competitiveness to enhance their abilities. (2) The social exchange theory This idea explains human behavior as an outcome of the exchange process. Profitable relationships will be maintained if they are worthwhile. In general, relationships that can cause harm are avoided. (3) Social consciousness. Reitz (2012) defines social competence as an individual's knowledge and abilities that influence the caliber of socially intelligent behavior.

Competence Recharging (CR)

We prefer the term 'recharging' over 'maintaining' due to the value and various connotations. Recharging refers to the condition in which the first time is complete, but as time progresses, it may diminish to half or less. When a person acquires a new skill, they desire to restore it to its initial state. In contrast, sustaining refers to a stable, neither higher nor lower condition. The employee must recharge their competence to compete with other skilled workers and be more productive, particularly during the epidemic of career shock eras (Akkermans et al., 2020).

Behavioral implications of psychological factors include acquiring new skills, processing information, and analyzing knowledge (Aprieliava et al., 2021). Psychological factors are always present throughout a person's life cycle, depending on their family background, socialization, or experiences. Social support or the responses of others, culture, educational environment, and economic standing are external or situational elements that influence the behavior and mindset of individuals (Chiru et al., 2012; Fan & Fan, 2021). In contrast, intrinsic components consist of self-efficacy, motivation, self-awareness, perception, and emotional state (Duminica, 2020).

The combination of extrinsic and intrinsic forces prompted individuals to decide and take action to improve their lives. Consistently achieving more excellent positions or wages is a goal of employees who maintain their productivity at work. People aspire to acquire new skills or abilities if they believe it would assist them in achieving their goals (Mulder, 2017). To develop skills, personnel should participate in relevant training or certification activities (Le Deist & Winterton, 2005). Although prior research has examined the motivations for individuals to pursue competency or skills training (Holahan, 2014; Lum, 2013; Mulder, 2017; Schaffar, 2021), no study has combined the intrinsic and extrinsic factors.



Theoretical Model

Legend: Supporting article number inside the brackets [1] Dulaimi & Hartmann (2006); [2] Mustajbašić & Husaković (2016); [3] Rijjanti et al. (2021); [4] Schein (1984); [5] Pallathadka (2020); [6] Kim et al. (2008); [7] Sigursteinsdottir & Karlsdottir (2022); [8] Lee & Raschke (2016); [9] Pitoy et al. (2021); [10] Vijayalakshmi & Yamuna (2017) ; [11] Bratton et al. (2011); [12] Chiaburu et al. (2010)

METHOD

Sample

This study selected respondents using a purposive sample. From 2019 through 2021, we collected data from workers who have maintained competency certification for two years. The respondent has a professional background and is an active worker. In 2021, 105 employees responded to an online survey addressed to all 235 employees registered with the certification competence institution.

Measurement instruments

Competence recharging scale

The competency recharging scale is based on Spencer & Spencer's (1993) theory, which identifies five aspects of competence: knowledge, skills, self-concept & values, personal qualities, and motivations. The five dimensions are bundled into a competency-maintenance-focused item. The results of the convergent validity test revealed that, out of 19 items, 12 were valid, and seven were eliminated, yielding an AVE score of 0.606.

Social support scale

The social support scale is based on social support theory with four dimensions: emotional, appraisal, instrumental, and informative (Langford et al., 1997). The convergent validity test results of 21 items obtained six valid items, and 15 items failed, with an AVE score of 0.624.

Motivation scale

The motivation scale is based on Deci et al. (1989) theory, categorizing three primary needs that motivate individuals to act: independence or autonomy, competence, and relatedness. The validity test results of 24 items obtained ten valid and 14 dropped items, with an AVE score of 0.628.

Organizational culture scale

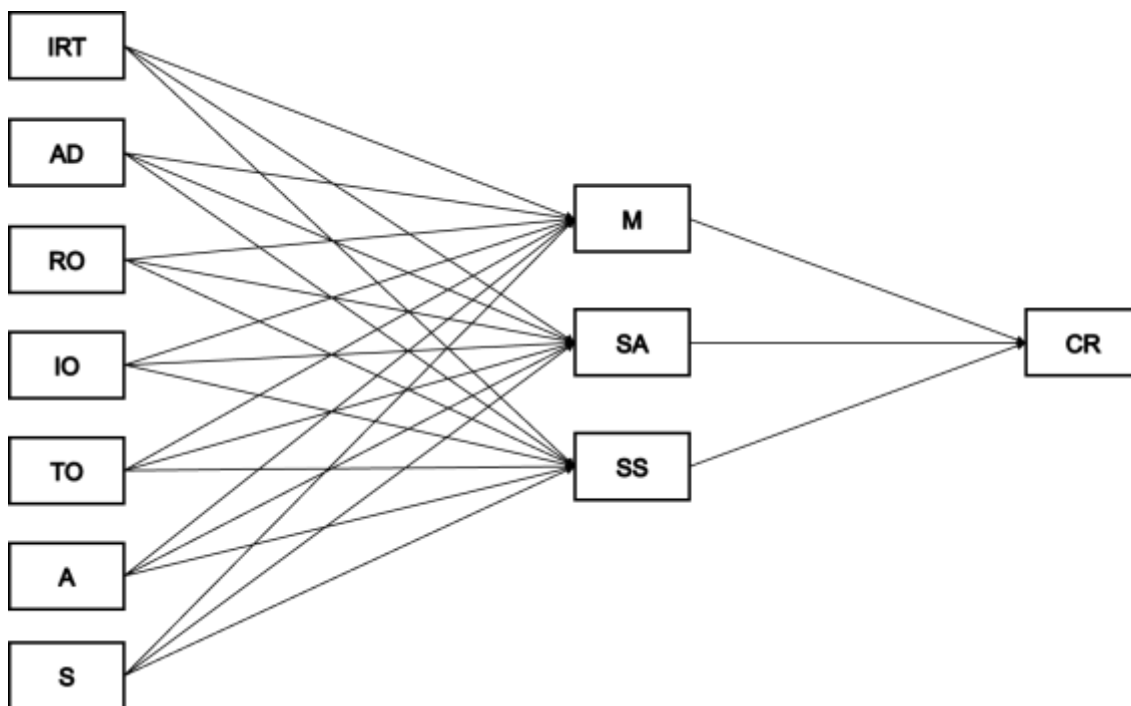
The organizational culture scale is based on Langton, Robbins, and Judge (2013). It includes seven dimensions of corporate culture: innovation and risk-taking, attention to detail, result orientation, human resource orientation, team orientation, aggressiveness, and stability. The validity test results of 29 items obtained 20 valid items and nine dropped items, with an AVE score of 0.624-1.00.

Self-awareness scale

The self-awareness scale has three dimensions: (1) emotional awareness, where a person can recognize one's own emotions and their effects, such as recognizing and understanding one's state, expressing emotions, and harmonizing emotions and actions; (2) accurate self-assessment refers to people being able to know their strengths and limitations, such as reflective, self-development and trying to learn; (3) self-confidence which means a deep understanding of one's abilities, believes in one's qualities, such as being able to voice opinions and make decisions (Boyatzis & Goleman, 1999). The validity test results of 18 items obtained nine valid items and nine fall items, with an AVE score of 0.578.

Statistical analysis

This study offered 24 hypotheses based on the literature review. The research model is as follows.



Notes: IRT, Innovation and Risk Taker; AD, Attention to Detail; RO, Result Oriented; IO, Individual Orientation; TO, Team Oriented; A, Aggressive; S, Stabilization; M, Motivation; SA, Self-awareness; SS, Social Support; CR, Competence Recharging

Figure 1. Research Model

RESULTS

We employed Smart PLS 4.4 to estimate the research model. This research is better suited to this model for the following reasons: First, the research model contains not one but two first-order reflective constructs. Test the mediating effects of intrinsic characteristics on the recharging of competence. Second, the sample size (N=105) is relatively small.

Before doing statistical analyses, collinearity and normality tests were conducted. To guarantee that collinearity is not a problem, the variance inflation factor (VIF) values of all construct elements must be less than 10. In this study, there are no dropped items on scales based on the VIF scores of each item. In the final study, 57 items across all components were included. Statistics of skewness and kurtosis utilize the normalcy assessment. The most excellent absolute values of skewness and kurtosis indicators in the remaining dataset were 2.102 and 5.602, which were much less than the threshold values of >2 and <7.

The adequacy of the measurement model was evaluated based on the criteria of reliability and validity. All constructs in this study have composite reliability values ranging from 0.878 to 1.00, above the threshold value of 0.7, indicating high internal consistency.

Table 1. Measurement Mode

Construct	No. of items	Mean	SD	VIF	AVE	Composite reliability	Cronbach's Alpha
CR	10	33.85	4.050	DV	0.606	0.939	0.927
M	8	26.77	3.323	4.502	0.628	0.931	0.915
SA	9	30.00	3.492	5.672	0.578	0.925	0.909
SS	6	19.06	2.831	2.350	0.624	0.909	0.879
IRT	4	13.46	1.715	3.002	0.646	0.879	0.818
AD	3	9.92	1.504	2.740	0.831	0.936	0.899
RO	5	16.79	2.290	6.184	0.769	0.943	0.925
IO	4	13.38	1.689	4.745	0.666	0.888	0.831
TO	4	13.30	1.744	4.004	0.705	0.904	0.858
A	2	6.62	0.892	4.005	0.783	0.878	0.723
S	1	3.30	0.499	2.005	1.000	1.000	1.000

Scale validation proceeds with the analyses of convergent validity and discriminant validity. The convergent validity of the scales was verified by using two criteria such as cross-loadings, and the average variance extracted (AVE) by each construct should exceed 0.5. As shown in Table 1, all cross-loadings of each construct item have higher scores than another, and all AVE values range from 0.578 to 1.00, achieving convergent validity.

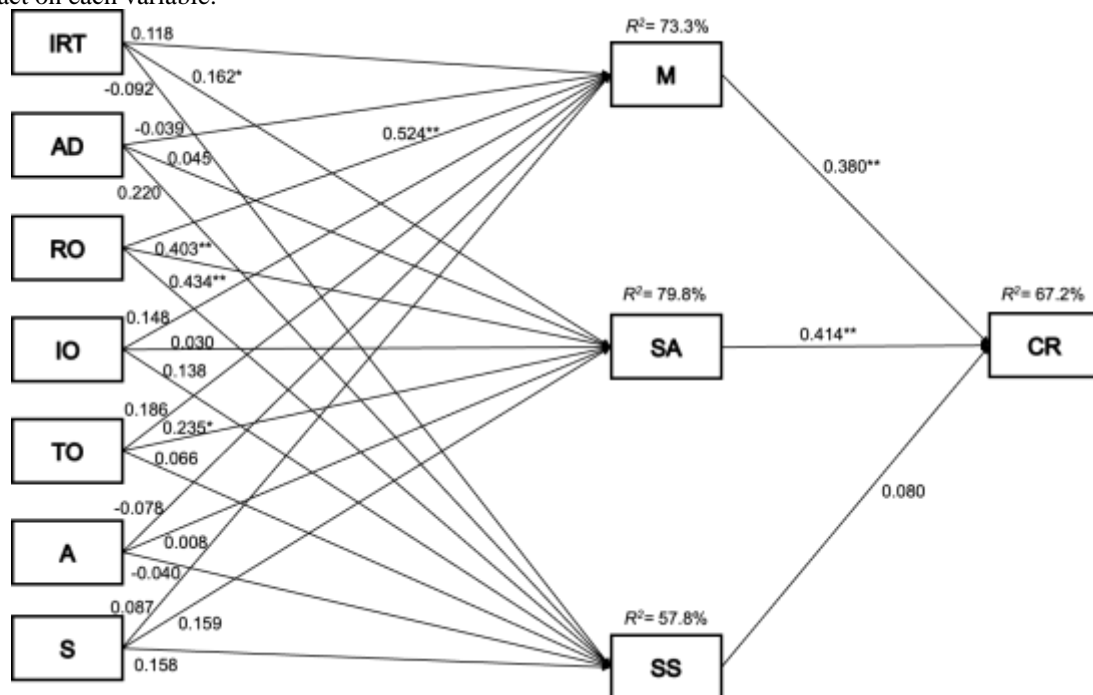
Table 2. Discriminant Validity

	A	AD	CR	IO	IRT	M	RO	S	SA	SS	TO
A1	0.894	0.664	0.606	0.718	0.558	0.598	0.640	0.486	0.705	0.527	0.788
A2	0.876	0.488	0.588	0.728	0.609	0.579	0.610	0.502	0.587	0.545	0.639
AD1	0.554	0.921	0.469	0.561	0.560	0.507	0.649	0.246	0.568	0.502	0.550
AD2	0.623	0.922	0.545	0.567	0.638	0.572	0.652	0.269	0.643	0.513	0.622
AD3	0.606	0.891	0.555	0.557	0.682	0.611	0.717	0.340	0.650	0.687	0.614
CR10	0.582	0.425	0.821	0.582	0.500	0.663	0.570	0.543	0.655	0.536	0.567
CR11	0.540	0.467	0.795	0.571	0.520	0.657	0.690	0.410	0.679	0.419	0.610
CR12	0.549	0.440	0.836	0.584	0.517	0.663	0.666	0.324	0.643	0.444	0.556
CR13	0.531	0.457	0.795	0.664	0.512	0.631	0.611	0.370	0.632	0.437	0.519
CR14	0.629	0.590	0.733	0.701	0.519	0.618	0.641	0.403	0.662	0.484	0.652
CR15	0.514	0.424	0.715	0.511	0.562	0.605	0.599	0.284	0.597	0.464	0.560
CR5	0.412	0.406	0.739	0.462	0.448	0.504	0.535	0.238	0.533	0.456	0.459
CR6	0.467	0.416	0.800	0.475	0.373	0.546	0.545	0.293	0.557	0.461	0.555
CR7	0.491	0.465	0.775	0.558	0.398	0.584	0.606	0.267	0.539	0.530	0.535
CR9	0.507	0.394	0.765	0.542	0.439	0.614	0.608	0.325	0.595	0.548	0.526
IO1	0.722	0.571	0.690	0.842	0.644	0.660	0.742	0.444	0.657	0.520	0.611
IO2	0.647	0.459	0.572	0.754	0.500	0.580	0.591	0.333	0.565	0.540	0.557
IO3	0.658	0.458	0.604	0.879	0.621	0.633	0.662	0.592	0.669	0.563	0.684
IO4	0.638	0.525	0.511	0.785	0.500	0.584	0.612	0.469	0.617	0.550	0.642
IRT1	0.635	0.574	0.458	0.517	0.829	0.475	0.553	0.362	0.606	0.390	0.548
IRT2	0.527	0.524	0.459	0.470	0.841	0.502	0.555	0.386	0.618	0.358	0.547
IRT3	0.404	0.552	0.383	0.496	0.732	0.510	0.639	0.283	0.515	0.516	0.458
IRT4	0.545	0.570	0.636	0.703	0.809	0.758	0.704	0.451	0.703	0.576	0.658
M11	0.526	0.550	0.528	0.540	0.600	0.704	0.695	0.362	0.640	0.649	0.603
M2	0.481	0.427	0.576	0.544	0.526	0.728	0.562	0.215	0.592	0.398	0.454
M3	0.567	0.412	0.649	0.606	0.584	0.772	0.619	0.377	0.633	0.536	0.537
M5	0.436	0.399	0.559	0.562	0.512	0.777	0.561	0.348	0.651	0.484	0.514

M6	0.523	0.454	0.616	0.544	0.487	0.797	0.607	0.465	0.677	0.452	0.662
M7	0.549	0.615	0.717	0.628	0.670	0.884	0.757	0.391	0.758	0.601	0.654
M8	0.551	0.549	0.664	0.705	0.573	0.849	0.727	0.477	0.721	0.651	0.618
M9	0.570	0.508	0.652	0.631	0.589	0.815	0.665	0.444	0.678	0.561	0.619
RO1	0.559	0.663	0.582	0.582	0.715	0.612	0.813	0.293	0.645	0.561	0.598
RO2	0.645	0.698	0.733	0.742	0.687	0.762	0.895	0.387	0.768	0.684	0.711
RO3	0.607	0.612	0.707	0.730	0.686	0.757	0.901	0.338	0.717	0.624	0.630
RO4	0.593	0.604	0.731	0.714	0.613	0.747	0.879	0.288	0.722	0.647	0.580
RO5	0.689	0.679	0.666	0.727	0.698	0.724	0.893	0.412	0.770	0.630	0.754
S1	0.557	0.317	0.450	0.566	0.469	0.491	0.393	1.000	0.575	0.451	0.610
SA1	0.494	0.498	0.513	0.510	0.561	0.582	0.462	0.513	0.754	0.403	0.584
SA2	0.492	0.434	0.515	0.557	0.547	0.625	0.500	0.503	0.764	0.445	0.553
SA3	0.556	0.463	0.538	0.619	0.566	0.620	0.601	0.417	0.776	0.467	0.585
SA4	0.532	0.478	0.609	0.513	0.493	0.678	0.607	0.448	0.713	0.498	0.674
SA5	0.548	0.555	0.621	0.648	0.601	0.664	0.746	0.412	0.799	0.489	0.625
SA6	0.646	0.645	0.679	0.647	0.655	0.747	0.762	0.442	0.807	0.616	0.699
SA7	0.501	0.473	0.648	0.589	0.643	0.677	0.667	0.296	0.735	0.483	0.560
SA8	0.561	0.540	0.643	0.535	0.565	0.571	0.614	0.363	0.740	0.391	0.597
SA9	0.654	0.565	0.590	0.625	0.618	0.611	0.654	0.543	0.748	0.671	0.615
SS1	0.478	0.584	0.472	0.513	0.500	0.513	0.570	0.308	0.544	0.824	0.448
SS2	0.552	0.521	0.602	0.655	0.550	0.668	0.650	0.439	0.638	0.766	0.555
SS3	0.442	0.491	0.466	0.473	0.439	0.526	0.592	0.306	0.469	0.845	0.451
SS4	0.388	0.423	0.440	0.388	0.450	0.510	0.517	0.359	0.509	0.747	0.517
SS5	0.408	0.452	0.449	0.449	0.392	0.493	0.514	0.315	0.434	0.795	0.472
SS7	0.560	0.496	0.450	0.619	0.414	0.518	0.538	0.387	0.491	0.758	0.572
TO1	0.418	0.544	0.493	0.492	0.474	0.499	0.535	0.331	0.531	0.456	0.709
TO2	0.776	0.580	0.709	0.752	0.665	0.720	0.734	0.636	0.774	0.637	0.885
TO3	0.705	0.453	0.618	0.689	0.632	0.627	0.609	0.590	0.695	0.481	0.905
TO4	0.766	0.631	0.553	0.604	0.555	0.611	0.612	0.448	0.675	0.557	0.845

Structured Model

We analyze the standardized path coefficients to examine the structure model and test the hypotheses. All organizational culture constructs are correlated with motivation, self-awareness, and social support in order to establish which construct has a greater impact on each variable.



Notes: IRT, Innovation and Risk Taker; AD, Attention to Detail; RO, Result Oriented; IO, Individual Orientation; TO, Team Oriented; A, Aggressive; S, Stabilization; M, Motivation; SA, Self-awareness; SS, Social Support; CR, Competence

Recharging

*p<0.05; **p<0.01; ***p<0.001

Figure 2. Structural model

The effects of organizational culture constructs on motivation, self-awareness, and social culture were investigated. Only one construct, namely result-oriented, was found to be strongly connected to the three variables. Particularly significant to self-awareness are innovation and risk-taking ($\beta=0.162$; $p<0.05$), result oriented ($\beta=0.403$; $p<0.01$), and team oriented ($\beta=0.235$; $p<0.05$). Then, only a result-oriented orientation is significant for motivation ($\beta=0.524$; $p<0.05$) and social support ($\beta=0.434$; $p<0.01$).

The structural model results showed that 67.2% of competence recharging could be explained by motivation, social support, and self-awareness. All the path coefficients in the model are reported and interpreted. The results in Figure 2 indicate that extrinsic factors have a significant effect on intrinsic factors. Social support has no significance on competence recharging ($\beta=0.080$; $p>0.05$). Moreover, motivation has significant positive effects on competence recharging ($\beta=0.380$; $p<0.05$). Self-awareness of competence recharging is also significant ($\beta=0.414$; $p<0.05$).

As shown in figure 2, two simple significant mediating effects exist in the research model: from motivation to competence recharging and from self-awareness to competence recharging. Both intrinsic factors are mediation for competence recharging.

DISCUSSION

Only three of the seven organizational culture constructs are related to the variables of motivation, self-awareness, and social support, namely innovation and risk-taking, result orientation, and teamwork. These three concepts are associated with personality and orientation toward accomplishing common objectives. In addition to being able to survive in a less stable current economy, it has been demonstrated that organizations with a culture that fosters innovation and emphasizes results-oriented teams are able to thrive. Moreover, only result-oriented is connected with the three dependent variables. This demonstrates that team-oriented professionals likely to receive both intrinsic and extrinsic reinforcement.

Self-awareness is associated with all major organizational culture components, including innovation and risk-taking, result orientation, and teamwork. The organization should stimulate employee innovation, emphasize teamwork, and support employee performance. These three combinations will increase employee self-awareness, which will have a beneficial effect on recharging competence. Self-awareness is an employee's intrinsic potential to activate themselves and contribute to the workplace without external coercion. Additionally, individual self-awareness is connected with desired effective results and greater managerial effectiveness (Bratton et al., 2011).

This study examined three key aspects in the recharging of employee competence: social support, motivation, and self-awareness. The combination of these three elements adds to 67.2% of recharging competence during the pandemic. Employees often replenish their competence via external and internal causes (Gurevitch, 2021). This study may consider extrinsic elements such as social support and workplace culture. In contrast, internal influences include self-awareness and motivation.

Companies that want their employees to recharge their competence should bring a positive corporate culture (Alsabahi et al., 2021), positive social support (Chiaburu et al., 2010), investigate the source of employee motivation (Rietveld et al., 2022), and facilitate employee self-awareness (Kreibich et al., 2020). Instead of being encouraged to interact with the business, employees will feel comfortable and have the freedom to develop their skills (Bakker & Schaufeli, 2008). The human resource manager could consider a program for employees that incorporates these four elements to provide a novel experience.

However, only self-awareness and drive have a substantial influence on the recharging of competencies. It might be argued that self-awareness and motivation are two of the most important internal elements, but occasionally people fail to recognize their importance (Atmojo et al., 2020). People require a pleasant environment to see their skills and potential. Self-awareness enables individuals to be more cognizant of their impulses, evaluate the hurdles, and choose the best path to achieve their objectives (Kreibich et al., 2020).

In contrast, social support has no important impact on recharging competence. This outcome contradicts studies that suggests social support is a crucial role in sustaining employees' willingness to acquire some competency (Fitriansyah et al., 2021; Pitoy et al., 2021; Vijayalakshmi & Yamuna, 2017). In addition, the ages of individuals might make social support a key influence. Younger people will require greater social support than elderly people (Chiaburu et al., 2010; Goodwin & Giles, 2003). Based on participant background, this study includes independent professional employees aged 24-55. It explains why social support does not have a substantial impact on recharging competence in this study.

Additionally, companies with a positive organizational culture are likely to meet their performance goals (Memari et al., 2013; Wabia et al., 2021). It is appropriate since the employee is invested in the organization and strives to meet the manager's requirements (Bakker & Schaufeli, 2008). Positive organizational culture will encourage employees to investigate their experiences, flaws, fruitfulness, and others' contributions prior to reaching self-awareness.

Limitations

This research has some limitations. First, the participant count must be replicated to obtain more thorough data. A month of data collection is insufficient to recruit the appropriate individuals. Second, the present study employs a non-random sample

with several restrictions. To obtain responders in future study, additional sampling methods, such as random sampling, should be considered.

Conclusion

This study examines the concept of recharging competence from the standpoint of how employees maintain the same skill level as when they were hired. Motivation, social support, and self-awareness are the three primary psychological variables necessary for recharging competence. Only social support does not affect recharging competence, whereas motivation and social support have a beneficial effect. Moreover, only three organizational culture components were associated with the three primary factors: innovation and risk-taking, result orientation, and team orientation. A company should examine these concepts to increase employee awareness, influencing the recharging of skills.

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COVID-19 accelerated digital transformation: The case of Meituan

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ABSTRACT

The outbreak of the COVID-19 pandemic caused disruptions in supply chains. While most existing research suggests ways to improve organizational resilience, our research raises the question of whether the pandemic has accelerated digital transformation at the organizational level. Using the case of Meituan in China, we investigate the supply chain disruptions caused by COVID-19, the strategies taken by Meituan to address the problems and their strategic implications. Starting as a fast food delivery company, Meituan has developed into a leading online shopping platform in China specialized in using digital technologies to provide on-demand delivery services. Our research on Meituan during COVID-19 shows that companies can leverage emerging technologies to improve business models and deliver long-term strategic benefits through digital transformation, rather than focusing solely on improving organizational resilience to reduce uncertainty risk.

Keywords: e-business, electronic commerce, q-commerce, real-time commerce, digital transformation, resilience, supply chain management, COVID-19 pandemic.

INTRODUCTION

The breakout of the COVID-19 pandemic has disrupted the flow of goods in the food supply chains globally and locally. Governments, companies and individuals were forced to cope with the disruptions and challenges due to the novelty of the coronavirus and the lack of an effective mechanism for the unpredictable and unfamiliar crisis, especially at the initial stage of the breakout of COVID-19.

COVID-19 has propelled companies to improve organizational resilience to reduce uncertainties. But the measures to improve organizational resilience are often associated with increased costs. There is a lack of empirical studies of the strategies that companies took in the real world to mitigate the risks and survive when the pandemic and resulting economic fallout have caused significant hardship.

Some research suggests that COVID-19 led to social distancing, lockdown and the new normal, which has profoundly accelerated digital transformation as one solution to avoid a total economic collapse (Soto-Acosta, 2020). The pandemic set the restrictions that have forced companies to adapt to a technology-intensive operational model and achieve digital transformation (Kudyba, 2020). But there is no consensus on whether COVID-19 accelerates digital transformation. Wade and Shan (2020) argue that digital transformation projects have a higher than usual failure rate, which means that companies are more likely to get into more trouble to solve problems caused by COVID-19. Their research suggests that as high as 70% of the projects fall significantly short of their objectives, owing to unrealistic expectations, limited scope, poor governance and underestimated cultural barriers (Wade and Shan, 2020).

This paper is an explorative study to address whether and under what conditions COVID-19 can accelerate digital transformation. Meituan, a leading on-demand delivery platform in China, was chosen to be our focal case. We investigate the challenges Meituan has faced during the COVID-19 pandemic in terms of supply chain management, because supply chain disruption is one of the key challenges caused by COVID-19. Instead of simply mitigating the risks, Meituan shows how companies may leverage the strengths of digital technologies and ride on the opportunities to achieve digital transformation, which can not only mitigate the negative impacts of COVID-19 but also create competitive advantages in the long term. We will also summarize the factors that lead to Meituan's success in accelerating digital transformation during the pandemic.

LITERATURE REVIEW

We will review the literature in terms of supply chain disruptions caused by the pandemic, organizational resilience and digital transformation.

Supply Chain Disruptions Caused by COVID-19

Most of existing studies of the disruptions to supply chain management focus on the global value chains (Miroudot, 2020; Phillips *et al.*, 2022; Gereffi *et al.*, 2022). The strategies companies can take to address the vulnerabilities and risks associated with the pandemic differ across industries. For example, some companies can buffer stocks, use different sourcing strategies

with in-built supplier redundancies (Phillips *et al.*, 2022) and rely on small-scale local production to enable decentralized design and manufacturing to address urgent needs (Kapletia *et al.*, 2019). Owing to supply chain disruptions, the pandemic can lead to reduced labour supply, reduced use of production capacity and shortages of parts and intermediate goods, while demand suffers from expenditure and consumption reduction (OECD, 2020).

In food supply chains, the disruptions caused by COVID-19 can be grouped into the supply side, the demand side and food security. The pandemic has a negative impact on food supplies, because of increased worker morbidity, supply chain disruptions and restrictive measures and individual governments' efforts to restrict food exports to meet national needs (Espitia *et al.*, 2020). The pandemic has also caused labor shortages, disruptions to transportation networks and the difficulties of moving goods across different areas (Hobbs, 2020).

The demand-side shocks also have an impact on food supply chains, including consumer panic buying behaviors with respect to key items and the sudden change in consumption patterns away from the food service sector to meals prepared and consumed at home (Hobbs, 2020).

Food security also becomes one of the key challenges of COVID-19. The food security issues, which are made worse by the pandemic, include inadequate food supply (availability), the difficulties for people to gain access to food supplies, inadequate nutrient intake and unstable food supplies (Laborde *et al.*, 2020).

Organization Resilience

Resilience refers an organization's ability to plan, absorb, sustain, and adapt to disruptions and unexpected crisis (Pettit *et al.*, 2010). With the ability "to anticipate potential threats, to cope effectively with adverse events, and to adapt to changing conditions" (Duchek, 2020), organization resilience enables a company to successfully confront the unforeseen (Michelman, 2017).

Organization resilience has long been recognized not only as a source of sustainable competitive advantage (Sheffi, 2007) but also a determinant of organization success (Coutu, 2002). Resilience focuses on a company's ability to resume business during disruptions, and the related organization robustness is a company's ability to go back to normal business operations after the pandemic (Miroudot, 2020). After the breakout of the pandemic, resilience has gained increasing importance as a key pillar of a company's strategies.

Existing literature has suggested the following ways to strengthen organization resilience in supply chain management to cope with the supply chain disruptions caused by the COVID-19.

First, a company can increase redundancy to give more breathing room for businesses to work after a disruption, such as holding more inventory, having more suppliers from different regions, building additional production capacity and so on. But this is an expensive and temporary measure due to extra costs of holding extra inventory, redundant production capacity and higher labor costs. In the long term, redundancy can inhibit a company's ability to improve efficiency (Choi *et al.*, 2020).

Second, a company can increase organizational resilience by building organizational flexibility (Choi *et al.*, 2020). For example, manufacturers can have interchangeable and generic parts, identical production facilities and systematically trained workers, which enables a company to quickly respond to a disruption by reallocating resources. Companies may also build up close supplier relationships by aligning suppliers with its procurement strategy. An intimate relationship with a small group of suppliers allows the company to monitor its suppliers and quickly detect potential problems. It is also more likely for the company to work closely with its suppliers to find a solution in unforeseen crisis situations. Alternatively, companies may choose an extensive supplier network to make its supply chain more resilient and responsive to the market.

Third, a company can build a corporate culture to help itself recover quickly and return to profitability (Choi *et al.*, 2020). A company can share their corporate goals, business strategies and operations with employees through effective and continuous communications. Employees have a good idea of the company's operations and make decisions when a disruption occurs unexpectedly. Frontline employees can take necessary measures in a timely fashion to avoid further damages. With the passion for work, employees feel happier and are more motivated to solve the problems.

In terms of supply chain management, resilience actions to cope with the pandemic have been categorized into four groups, including systems (structures, resources, capacities, interactions), process (distribution, transportation, procurement, production, resources allocation, flexibility), control (inventory control, sourcing control, manufacturing control, resilience as KPI in optimization models) and recovery (manufacturing production, human labor, transportation network, suppliers, production flexibility). (Queiroz *et al.*, 2020)

However, resilience studies have focused on reducing uncertainties and risks, which may overlook opportunities created by uncertainty. Individuals and organizations may not simply aim to reduce uncertainties. Griffin and Grote (2020) argue that individuals do not simply seek to reduce uncertainty, but sometimes create uncertainty which is functional and adaptive for themselves and others. They suggest that on the organizational level, the company may be regarded as an information-

processing agent acting in an endogenous context and embedded within a wider exogenous context of economic, social and environmental conditions. In other words, in the case of the COVID-19, companies may not only want to reduce the risks and uncertainties, but also want to consider its own social context and take actions, such as using digital technologies to improve business operations, which may create new uncertainties and generate strategic benefits.

Digital Transformation

Digital transformation is defined as “a process where digital technologies create disruptions triggering strategic responses from organizations that seek to alter their value creation paths while managing structural changes and organizational barriers that affect the positive and negative outcomes of this process.” (Vial, 2019) Most digital technologies are referred as SMACIT, that is, the technologies related to social, mobile, analytics, cloud and the Internet of Things (Sebastian *et al.*, 2017).

Digital transformation involves disruptions to the existing business processes which will change the existing value chain. Digital transformation will bring out changes to existing business models or ways of operation. Since the COVID-19 pandemic has caused supply chain disruptions, coping with the disruptions requires organizational changes anyway. Therefore, it is possible to align the strategies of coping with COVID-19 with the objectives of digital transformation efforts. But it should be aware that digital transformation itself will also bring positive and negative outcomes to the company.

Digital transformation is often driven by technological advancements, changing customer behavior and intensifying industry competitions (Verhoef *et al.*, 2021). The breakout of COVID-19 has not only changed customer behavior but also changed the business environment and competitive landscape, so the crisis has the potential to drive digital transformation.

Organizational research suggests that companies invest in and/or use digital technologies are twice more likely to have a higher revenue than their peers (LaBerge *et al.*, 2020). A number of studies have suggested that digital transformation strategies can help to cope with the pandemic at all levels. In Saudi Arabia, the Saudi Vision 2030 framework released in 2017 which paved the path for digital transformation, was promoted and tested during COVID-19 (Hassounah *et al.*, 2020). On the city level, research suggests that a virtual online food resilience and contingency hub can shorten the city’s food supply chain to improve disaster response, resilience and contingency-planning agenda (Reis *et al.*, 2022). Other research has suggested that COVID-19 has shortened the process of using computers in companies and universities.

However, there is a lack of empirical studies on the corporate level regarding to whether COVID-19 can accelerate companies to carry out organizational change and achieve digital transformation with the potentials to bring long-term strategic benefits to the businesses.

RESEARCH METHODOLOGY

We chose to use case study because the case method is suitable for studying “a real-life, contemporary bounded system.” (Creswell, 2013). Yin (2003:13) defines case study as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.”

Using the case method allows us to investigate what strategies companies used to cope with the COVID-19 pandemic in the real world. We want to find out whether COVID-19 can accelerate digital transformation on the corporate level. As discussed in the above literature review section, there is a lack of empirical studies on the organizational level focusing on using digital technologies to improve business performance. Therefore, our research is explorative in nature, and we only need to identify a company to show that it is possible that COVID-19 could accelerate a company’s digital transformation process under certain circumstances.

We choose one single case instead of multiple case studies because a single case study is the best choice when we want to study one single issue (Yin, 2003), that is, whether the COVID can accelerate digital transformation. A single case allows researchers to get a deeper understanding of the issue (Dyer and Wilkins, 1991), while multiple case studies are more suitable for comparing the results across situations (Yin, 2003) in order to clarify whether the findings are valuable or not (Eisenhardt, 1991).

We chose Meituan as the focal case for the following reasons. First, we need to choose an industry which was still operating during the pandemic. Some industries, such as theatres and amusement parks, had to close down when the pandemic was at its peak and the most stringent period of epidemic prevention measures were implemented. They had to stop operating or changed their business nature during the pandemic. Survival is of the utmost importance for them. As our research focuses on whether the use of digital technologies to cope with the pandemic and to facilitate business growth, our focal company needs to continue operating in the same business area. This makes Meituan a good choice to achieve our research objective. Meituan is engaged in the on-demand logistics and delivery industry, and the pandemic had a noticeable impact on the industry in terms of supply chain disruptions.

Second, Meituan is a leading on-demand food delivery online platform, therefore technology is playing an important role in its business operations. Thus Meituan is more likely to leverage digital technologies to improve their business than companies in other industries. Meituan can provide a good opportunity for us to study their IT strategies during the pandemic.

MEITUAN

Meituan was established by Wang Xing in Beijing, China in 2010 and was listed in 2018 on Hong Kong Exchanges. Meituan has grown from a group-buying website into China's leading e-commerce platform over the years, offering a wide range of local lifestyle services to customers, including food and grocery delivery, travel and hotel services, online reviews and transportation services.

Meituan's mission statement is "We help people eat better, live better" by focusing on the "retail + technology" strategy, working with merchants and business partners to provide consumers with a quality life. Leveraging on its technological strengths, Meituan promotes the digital transformation of commodity retailing and service retailing on both demand side and supply side.

In January 2019, Meituan launched the "Meituan grocery shopping" app to serve community residents. Community residents living in a surrounding area of a designated community can place orders to buy groceries using this mobile app, and pick them up at community service stations or have the goods delivered to their homes. Meituan Grocery Shopping focuses on offering carefully selected high-quality products at highly competitive prices with punctual and fast delivery services to customers. During the initial testing period, the goods could be delivered as fast as 30 minutes, and Meituan showed its ability to provide fast and convenient service to people.

In China, the on-demand economy has grown very fast in recent years, which has facilitated the growth of the on-demand food and grocery delivery industry. The market size of China's on-demand economy grew from RMB 1,292.4 billion in 2017 to RMB 1,711.8 billion in 2021 (Huaon.com, 2022). Meituan has become the world's largest on-demand food delivery service provider. In December 2021, Meituan Delivery had 62.64 million monthly active users (MAU), compared to rivals Ele.me (58.07 million) and Baidu Delivery (8.91 million) (Thomala, 2022). In 2021 financial year, Meituan's total revenue reached RMB 179.728 billion, a year-on-year increase of 56%, of which the delivery business revenue was 96.312 billion, a year-on-year increase of 45.3% (Huaon.com, 2022). In the first quarter of 2022, the number of active merchants using Meituan increased 26.6% year-on-year to 900 million. The annual average transaction frequency of active users increased by 21.9% year-on-year to 37.2 transactions. In terms of expenses, costs related to food delivery increased by RMB 1.8 billion to RMB 17.2 billion, in which R&D expenditure increased by 40% year-on-year to RMB 4.9 billion, accounting for nearly 11% of revenue. (Yicai, 2022)

SUPPLY CHAIN CHALLENGES TO MEITUAN DURING THE COVID-19 PANDEMIC

The challenges Meituan has faced during COVID-19 can be summarized into four aspects, including sudden surge in demand, demand shocks, social distancing measures and supply shocks.

Sudden Surge in Demand

The pandemic caused a sudden increase of customer demand for delivery services. The breakout of the pandemic significantly boosted up the demand for online grocery shopping due to lockdown measures, consumers' panic buying and social distancing intent. In 2021, the per capita consumption expenditure of online food delivery in China reached RMB709.6, a year-on-year increase of 49.6%, accounting for 21.4% of the per capita consumption expenditure on catering (Huaon.com, 2022). In the first two months of 2022, especially during the Spring Festival, Meituan increased the number of merchants offering New Year Eve dinners to broaden consumption choices as more people chose to stay locally to celebrate the Chinese New Year, instead of going back to their hometowns, so the proportion of orders with high order prices in the total order volume increased.

Demand Shocks

It is difficult, if not impossible, to predict the ebb and flow of demand due to the pandemic. Between March and June 2022, due to the impact of the pandemic and the control measures in some areas, many businesses were suspended and many riders were quarantined. As such, the food delivery business was largely affected by supply constraints and contract performance constraints. In Shanghai, for example, the number of orders went down 90% than before. Due to the higher risk of contagion, this outbreak was different from the outbreak in early 2020 and had a different impact on business. According to Wang Xing, the CEO of Meituan, in view of the pandemic, the growth of orders in the second quarter of 2022 will slow down compared to the first quarter (Yicai, 2022).

Epidemic Prevention Measures

During the pandemic, many communities implemented very strict epidemic prevention measures, such as community access control, road blockade measures and so on. Riders were no longer able to enter into communities freely, which undoubtedly had a negative impact on Meituan's business. Moreover, in some areas with severe COVID-19 outbreaks with strict lockdown measures, people were not allowed to move around and had face-to-face contacts. These measures made it difficult for Meituan to deliver goods to customers on time.

Supply Shocks

There was a shortage of labor supply during the pandemic for a number of reasons. Riders could suddenly get sick and have to stop working immediately. Some riders may live in the restricted areas and are not allowed to leave or move around due to the

sudden outbreak. Some riders may pass or deliver goods to areas with a sudden outbreak, and they must be quarantined and unable work for a period of time. Additionally, the pandemic also makes it more difficult to recruit and train new riders.

MEITUAN'S STRATEGIES

Autonomous Driving Vehicles

Faced with the situation that many districts were closed and under control and people were not allowed to move around in those areas during the pandemic, Meituan launched new technologies including unmanned automatic delivery vehicles to solve the problem of timely delivery of goods. For example, Meituan dispatched autonomous delivery vehicles to Shanghai to provide contactless delivery and boost capacity. Between 1st April and 24th May, Meituan autonomous driving vehicles delivered a total of 703,000 orders (Yicai, 2022).

Drone Delivery

In 2021, Meituan opened the first drone delivery business district in Galaxy World in Longgang District, Shenzhen, Guangdong Province. This is the eighth route opened by Meituan drones in Shenzhen in 2021 and the first pilot operation in business district.

Meituan has carried a set of intelligent meal recognition algorithm on the drone in order to prevent overloading. They put a number of QR codes on the ground at the take-off point to provide the drone with the identification information of the airport, so that the drone knows where it is and where it is going.

To complement the operation of UAVs, Meituan has developed an unmanned aerial vehicle (UAV) planning dispatching system, and the background automatically sends instructions to the UAV to indicate the route. Meituan also designed a space-time capsule for drone operation. The virtual capsule can show how the location of the drone changes over time. If several drones are operating at the same time in the same area, as long as the capsules do not touch each other, there is no operational risk.

The drone carries SIM cards of multiple operators, so that through a set of autonomous switching algorithms, the drone knows which operator has a better signal. The drone will land on the community service station developed by Meituan itself, and the lunch box will automatically enter the pickup cabinet. The customer will receive a password in the registered mobile and use this password to take out the lunch box from the pickup cabinet.

Community Order Collection Service

During the lockdown period in Shanghai in early 2022, a community order collection service was launched for residents under lockdown. Meituan launched a community group meal buying model to supplement the traditional takeaway model, providing more than 400,000 group meals to about 9,000 communities. In Beijing, Meituan has increased its rider capacity to 30% and offers long-distance deliveries in light of the ban on eating out and dine-in since 1st May. The launch of the city-wide takeaway service has driven a surge in demand for high-priced, long-distance orders. (Yicai, 2022)

New Rider Training

Facing the shortage of manpower during the pandemic, Meituan has launched a three-piece package to give a helping hand to new riders on 14 July 2022. The first one is a one-to-one helping scheme, with experienced riders guiding new riders. It has helped new riders improve their delivery skills and earn higher incomes. As some orders are more difficult than others to deliver and fulfill, Meituan has prepared a "novice checklist" to allocate easier tasks to new riders. Finally, Meituan has developed a "novice waiver card" that provides additional waiver opportunities to new riders. After introducing the three-piece package to new riders, the job satisfaction rate of new riders improved 13.5%. This package not only gives more time for new riders to improve their delivery skills but also attracts more people to join Meituan as riders.

Improved Logistics System

Facing the increasing demand for Meituan grocery shopping during the pandemic, Meituan is building up its own logistics system. At present, Meituan grocery shopping has established at least 15 front warehouses, of which there are 8 in Beijing alone.

Meituan launched the "unmanned micro warehouse" plan, which helps implement Meituan's front warehouse plan. Meituan's front micro warehouse is measured between 50 to 200 square meters each. These unmanned warehouses can handle orders 7 times faster than traditional picking warehouses. Meituan's unmanned warehouse has reduced the industry's best sorting cost (RMB 1.5 per order) by 50%.

Moreover, Meituan has integrated warehousing, sorting and distribution and set up community service stations. After the community customers within the service scope can place orders to buy food on the app, and they may choose to pick up the goods from the community service station or have the goods delivered by the community's full-time Meituan delivery staff.

Table 1: Summary of Meituan's Strategies

Meituan's Strategies	Key Features	Solutions to COVID-19 Problems	Strategic Benefits
<i>Use of Autonomous Driving Vehicles</i>	Unmanned vehicles Contactless delivery	Epidemic Prevention Measures Demand and supply shocks	Timely delivery Increased labour supply elasticity
<i>Drone Delivery</i>	Unmanned vehicles	Epidemic Prevention Measures Demand and supply shocks	Timely delivery No road traffic uncertainties Increased labour supply elasticity
<i>Community Order Collection Service</i>	Mobile ordering Group meal buying	Epidemic Prevention Measures Sudden surge in demand Demand shocks	Economy of scale Increased service supply capacity Increased profit margins
<i>New Rider Training</i>	Three-piece package: One-to-one help Novice checklist Novice waiver card	Supply shocks	Rider recruitment Rider training Rider retainment
<i>Improved Logistics System</i>	Micro unmanned warehouse	Supply shocks Sudden surge in demand	Faster order handling speed Lower sorting costs Higher profit margins
<i>Supplier Quality Control</i>	"Meituan Optimal" app Grocery Shopping app On-demand ordering Next-day delivery	Supply shocks Demand shocks	Demand forecast for suppliers Quality guarantee for customers More quality suppliers More satisfying customers

Source: This study.

Supplier Quality Control

In face of increasing demand during the pandemic, the choice of suppliers becomes critical. To attract more quality suppliers, Meituan allows supplier to apply using its app. Suppliers need to first download the "Meituan Optimal" app by giving the company name, main products and product categories and areas of origin in the information interface. Then, they need to upload their business license along with contact details, including the WeChat name, email address and phone number, to the system and submit to Meituan. If approved by Meituan, they can officially become a platform supplier.

Every morning, workers at the Meituan Select Vegetable Base come to the supplier's field early, pick the items ordered by customers and assemble them for delivery. Customers will receive their goods the following day. The whole process is managed and monitored by Meituan's system. This system gives Meituan a competitive advantage in the post-epidemic era, as it is expected that vegetable supply is increasingly relying on the Internet. Community e-commerce, represented by Meituan Grocery Shopping, is a kind of shopping method of "pre-purchase + self-pickup". This business model considers each community as a separate unit that allows customers to place orders online. Meituan Grocery Delivery's system features on-demand ordering and next-day delivery, and can also help suppliers predict the demand for their agricultural products and plan production based on the platform's accumulated order big data.

DISCUSSIONS

Our research shows that digital transformation can provide an opportunity for companies to perceive, seize and transform the supply chain disruptions into innovation opportunities by the use of emerging technologies. Facing the shortage of labour and the lockdown measures which caused supply chain disruptions, Meituan has changed the mode of delivery, using drones to deliver fresh produce to customers. This changes the existing mode of delivery, which mainly relies on riders. To smoothen the process of transformation, Meituan is also recruiting and training staff new skills to use drones. Therefore, the supply chain disruptions caused by the COVID-19 pandemic has become a driving force behind Meituan's digital transformation efforts.

Moreover, Meituan's use of drones to provide delivery services is a good example of how the pandemic has accelerated the company's digital transformation in its supply chain. Meituan was not the first to make logistics drones. Google's associated company Wing and Amazon's PrimeAir have been exploring logistics drones since 2012. It took Wing 5 years from its establishment to the completion of the first order in the real world, but it took Meituan only 3 years. Wing spent 9 years completing 100,000 real user orders, and Meituan is expected to take 5 years (Wei, 2021).

Sending out the first order might only be a technical exploration issue. But the difficulty lies in how to allow more people to use their services. It is a very complicated problem that needs to take into account urban environment, community living environment as well as user experience. The outbreak of COVID-19 stimulated customers' needs for fast and quality grocery shopping while keeping social distancing, which has given the incentives for customers to try out new services and accelerated the process of using logistics drones.

In the long term, the use of logistics drones may bring the following benefits to Meituan. First, the use of drones has transformed two-dimension logistics and delivery model into a three-dimension model. The delivery, for example, will no longer be delayed by traffic jams and other unexpected road accidents. Second, it can significantly improve customer experience and efficiency if using appropriately. Third, it can enhance Meituan's delivery capacities. Finally, it can significantly improve operational efficiency (Wei, 2021).

While COVID-19 has accelerated Meituan's digital transformation and brought the company long-term benefits, we argue that not all the companies are able to do what Meituan has achieved. We have analyzed and summarized the following enablers:

A Clear Objective of Digital Transformation

To ride on this opportunities, companies need to plan ahead and get prepared to use digital technologies. Meituan has been using digital technologies to build up its online ecosystem and improved delivery and customer services. The pandemic facilitated the process that Meituan used drones for delivery. It was very likely that it would not have happened so quickly because the outbreak of the COVID-19 pandemic immediately boosted up the market demand within a very short period of time. In the case of Meituan, the company had the plan of using emerging technologies, such as drones and unmanned autonomous delivery vehicles, and had been working on these plans before the breakout of COVID-19.

Even though the crisis may take place unexpectedly, the company should not wait until a crisis takes place to make a plan of digital transformation. Meituan started exploring the possibilities of using drones as early as 2017. The company started investing in developing drone technologies when Yinian Mao, the person responsible for developing drones, joined Meituan by the end of 2018. Mao led the team in Meituan to develop drone businesses. They carried out research in drone businesses, and all core components, from drones, automated airports to dispatch systems, were self-developed. Now Mao's team has more than 300 engineers.

Developing a fully automated system to dispatch a large number of drones to deliver food, we are facing the difficulties equivalent to climbing the Mount Everest in the field of drones. (Using drones) is very risky. As long as there is a complaint, it may be grounded and game over.

-Yinian Mao, Head of Drones, Meituan (Wei, 2021)

Despite such a huge investment, the underlying logic of Meituan's drones had not been disclosed and kept secret by the executives and even within the company until the company made a public announcement in July 2021. In Meituan's announcement, the goal of using drones is to build an urban low-altitude distribution network with a radius of 3 kilometers and delivery in 15 minutes, and shuttle between communities, office buildings and shopping malls (Wei 2021). Therefore, even before the breakout of the pandemic, Meituan has a clear vision of developing and using logistics drones. This finding echoes Wade and Shan's (2020) suggestion that the best starting point to avoid the failure of digital transformation projects is to make the objective of the transformation as clear as possible.

Risk Awareness and Management

While COVID-19 may accelerate the digital transformation process of a company, it has brought more unexpected risks and challenges due to the shortened preparation time. Therefore, companies should be prepared to cope with these risks and challenges.

In the process of using digital technologies, Meituan also faced such unexpected challenges. For example, nearby residents complained that community service stations were too noisy, and an increased level of delivery traffic brought new security concerns to the community. Residents also complained that using drones disrupted their midday nap, as a result Meituan decided that the drone had to veer off course.

IS projects have long been recognized as more difficult to manage than non-IS projects in terms of complexity, conformity, changeability and invisibility (Brooks, 1995). Therefore, companies need to consider technical and social technical changes associated with digital transformation. Digital transformation involves organizational changes, creating positive and negative impacts on companies. In order to successfully align the objectives of digital transformation with the objectives of solving supply chain disruptions, companies should be very careful to evaluate the negative impacts and get prepared to cope with the unexpected consequences (Wincewicz-Bosy *et al.*, 2022).

During the post-pandemic era, companies should be aware of the potential risks and challenges. As Wincewicz-Bosy *et al.* (2022) suggest, after supply chain disruptions, restoring the capacity and restarting the food supply chain is a complex, multi-faceted task that requires multi-directional actions in terms of management processes (organization, information system

supporting decision-making processes, procedures) and logistics (transport, storage, food serving, waste collection), manufacturing and technology (production, food processing), and relationships (partnership, trust, responsibility for safety, communication).

CONCLUSIONS

We use the case of Meituan in China to show that it is possible for companies to leverage digital technologies to not only solve the supply chain disruptions caused by the COVID-19 pandemic but also bring long-term strategic benefits by achieving digital transformation. The COVID has sped up Meituan's process of using drones and unmanned autonomous vehicles to deliver food and groceries to their customers. By analyzing the case of Meituan, we argue that companies need to have a clear objective of digital transformation and get prepared to cope with the challenges and risks associated with digital transformation if they want to ride on the opportunities of unexpected crisis situations, like the COVID, to accelerate digital transformation. Otherwise, considering the high failure rate of digital transformation projects, we believe that such projects might bring more uncertainties and unexpected problems than solving the challenges brought out by the COVID.

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Developing and validating a scale to identify the employability skill set vital for the frontline workers: A case of hospitals in Delhi/NCR

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ABSTRACT

The purpose of this study is to identify those imperative skills required by an oligopolistic industry (healthcare) to provide significant services so as to ensure maximum customer satisfaction. Employability skills are those essential skills which are required in the workplace. Researchers are consistently analyzing it on multiple fronts and domains to help the industry identify the right person for the right job. Unfortunately, there is still a dearth of studies which have precisely recognized the employability skill set for frontline workers in hospitals. In this paper, researchers have successfully developed and validated a scale to measure the employability skill set required by frontline workers in the healthcare industry. Researchers have developed a research scale consisting of nine essential dimensions of skills. For validating the scale, a sample has been collected from 400 respondents, having at least 10 years of experience in the Medical Service Vertical using stratified random sampling. The medical service vertical comprises both front-end and back-end jobs. The skill set varies at each level and as per the key responsibility areas. An employability skill set scale has been developed, encompassing the required soft and technical skills. The study intends a significant positive correlation, which means that any positive variance in one leads to a corresponding affirmative variability in the other. This study will further assist researchers who want to develop tailored training programmes for frontline workers.

Keywords: Employability skills, training, healthcare industry, India, scale, EFA, CFA.

INTRODUCTION

The healthcare industry is at the epicenter of the global pandemic challenge. The entire globe is dependent on healthcare facilities, which include medication, hospitalization, recovery, and vaccination. In most countries, healthcare facilities are under the direct control of the government to ensure the best healthcare amenities for its citizens. With an overall revenue of around US\$ 2.8 trillion, the healthcare firm could be the world's largest sector. (IBEF report, 2019). It is expected to be one of India's primary economic drivers. It is the fourth largest employer in the country, offering employment both in the public and private sectors. (Irshad & Abidi, 2020).

The healthcare sector is mostly a knowledge-based, experience-based, and stable industry. Hospitals, like other businesses, have well-defined vertical and hierarchical structures. The requirements for generic, specialist, and technical abilities vary by level. The prospective skills required at each level should be examined and carefully defined well before the training programme is designed. The Medical Service Vertical (MSV) is made up of Line Services, Supportive Services, and Auxiliary Services.

With the unprecedented importance and growth of the healthcare industry, it has become essential to choose the right skill for the right job. As the medical service vertical includes services such as outpatient, inpatient, emergency, registration, ICU (Intensive-care unit), transport, security, diet services, and radiology, it is paramount that services must be effective and efficient. Most of the research conducted in the past focused on broader aspects of competency and professionalism (Dong *et al.*, 2017). In this study, a novel definition and conceptual skill framework are identified and analyzed, involving multiple stakeholders to reduce the gap between perceived services and actual services. (Dorri, Akbari, & Sedeh, 2016).

The term "employability" is not generic; rather, it implies those skills, competencies, characteristics, and experiences required to achieve higher performance. We are moving from Industry 4.0 to Industry 5.0. The skill set is changing with the organizational structures. The introduction of artificial intelligence in the healthcare industry has made it robust and technology-oriented. Usually, the medical service vertical is a perfect mix of sincerity, punctuality, emotional intelligence, social intelligence, technical intelligence, and critical thinking.

Employability skills are one domain that is less explored when it comes to the Healthcare Industry in India. Exploring the Employability Skill (ES) required by frontline workers at all levels will aid in gaining a better understanding of the diverse skills required by professionals (Eisenbeiss, Van, & Boerner, 2008). It is expected to solve the leading problem of the minimum required skills to get employed in hospitals in India. So, the purpose of the current study is to set up and test an ES scale that could be used in future empirical studies.

This study focuses on pre-requisite skills essential for professionals working in the medical service vertical. Since the medical service vertical comprises various major dimensions such as nursing, emergency, ICU, stores, outpatient, etc., all of these play a significant & effective role in patients' education. It focuses on providing a high quality of care and minimizing medical errors by practicing health preservation and improvement (Dorri et., 2019). Further, this research has been carried out with the objective of carefully analyzing the vital skills, behaviors, and attributes required at the MSV of the healthcare industry.

This study is divided into four sections. Critical literature reviews on employability skills and skill-based training in the healthcare business are discussed in the first segment. The second section represents the research methodology of the study. The third segment includes the analysis and interpretation of the information gathered. The last section discusses the remarks, practical implications, limitations, and future direction.

LIETRATURE REVIEW

Baxter and Young (1982) have demonstrated that businesses need entry-level employees who are reliable and dependable, have fundamental skills such as communication, leadership, problem-solving, analytical and critical-thinking, and a desire to learn and grow, so as to work effectively and efficiently as a part of a team, and have a legitimate demeanor. Employability also implies that individuals who have the abilities to perform the required work may not be able to do so immediately without additional training (Cox & King, 2006). As organizations need to change, employers are looking for workers who can adapt and do a lot of different things. Most of the researchers address the need for employability skills (ES) for a university graduate. There is limited literature available that discusses the need for ES for existing professionals in the healthcare industry (Sheldon et al., 2005; Shrader et al., 2013).

Employability skills (ES), as per Munro (2007), include the capacity to improve the effectiveness of work in an organization as well as strong verbal communication and critical thinking skills, which have been the foundations of both academic and professional success. Bennett et al. (2000) contended that ES includes not only the traits of prospective employees but also the basic criteria and the individual needs to be assessed for employment. These competencies are required to do work efficiently and make a significant contribution to an organization's sustainability. ES's are an assemblage of skills that assist in fostering an individual's aptitude to perform efficiently and effectively in the workplace (Singh et al., 2013). Employability skills are sometimes referred to as "transferable skills" or "soft skills" or "generic skills."

According to Clarke (2007), basic abilities such as cognitive, resource, interpersonal, systemic, and technological skills, as well as personal attributes, are all included in employability skills. Moreover, ESs are a set of important characteristics ingrained in each person in order to create a skilled and competent workforce (Kazilan et al., 2009). This is similar to people who have strong traits such as a high degree of self-innovation, efficiency, ability, and competitiveness, as well as a strong sense of commitment and ingenuity in dealing with worldwide challenges. The need for skill-based training for front-line workers in hospitals in India Competent employees are the backbone of all the service industries, as they are the people working both at the front end and the back end of the organization. As a result, in order to compete in a competitive world, healthcare service providers must improve their strategy by providing high-quality, low-cost care services to their patients. (Francis et al., 2006; Kotler & Keller, 2007).

Human capital development is a critical method for sustaining such a competitive edge. (Frei, 2008). In hospitals, human resource practitioners are facing challenges such as recruiting, up skilling, and retaining skilled manpower (Arasli et al., 2006). Front-line workers (FLWs) are designated as the face of the health industry. These are front desk agents, security guards, floor attendants, emergency unit staff, store department, etc. All the employees working at the front play a decisive role in the brand building of the organization because they are engaged in face-to-face dealings with the patients, thereby providing additional value and assuring service industry sustainability (Karatepe & Ehsani, 2012). As a result, one of the most essential snags in the service business is attracting and retaining these types of personnel for a long time. (Chebat et al., 2002; Babakus et al., 2003; Alexandrov et al., 2007). There has been limited research conducted in the past that explains the challenges faced by human resource management (HRM), such as rapid technological change and dynamic work culture, predominantly in the health-care sector. The healthcare industry is a live example of such encounters. Researchers have identified that HRM practitioners face copious challenges, especially in acquiring and retaining key talent, up skilling them, augmenting performance, and budding the mindset of the workforce as the organization intensifies in magnitude and capacity (Kotter & Sathe, 1978; Barringer, Jones, & Neubaum, 2005; Budhwar et al., 2006).

In order to ensure quality, care, and safety, human resources are a crucial and critical factor of healthcare service performance. (Bartram & Dowling, 2013). There are many ideas introduced in past research to increase the efficiency of frontline workers. Firstly, healthcare outcomes are extremely complex as they face continuous pressure to become efficient, innovative, and deliver quality healthcare services. Secondly, as frontline workers are the front faces of hospitals, it is indeterminate and difficult to measure the quality. Thirdly, healthcare outcomes are public-oriented. Hospitals cannot, in most circumstances, be arbitrated on the basis of effectiveness and brand image. Finally, healthcare organizations are predominantly multiplex due to their dual lines of responsibility and accountability: professional and administrative (Agarwal, Garg, & Pareek, 2011). Earlier, there was no concept of formal training in the workplace. But nowadays, training is referred to as a building block and regarded as a tool for human resource development (NSDC report 2019). Over the past few years, healthcare providers have faced several issues related to soft skills training for their frontline workers. Employability skills are not necessarily developed

at university. However, they are highly valued at the time of placement and during the course of work (Ray et al., 2013). A study was conducted at 36 universities providing healthcare education, where students were asked to analyze their skills. They felt that it was necessary to attain a high level of skills for learning, teamwork, problem-solving, communication, and ICT skills (Moore et al., 2018; Roberts et al., 2016).

Most of the researchers (Taylor, 2005; Manser et al., 2009; Suresh & Kodikal, 2015; Williamson et al., 2016) suggest that effective human resource utilization is important to evaluate skills at each hierarchical level. Professional quality and perceived satisfaction vary across the levels of a healthcare organization (Sinclair et al., 2016). Various leadership styles are visible in the healthcare industry, viz. formal, i.e. transformational, transactional and empowering, and informal. It means that leadership is distributed in the healthcare industry.

Classroom training, according to Pineda (2010), Mora et al. (2011), Mehaj-Kosumi (2013), & Vij et al. (2014), focuses on skills such as communication, teamwork, and problem-solving. The stimulation-based training programme designed and developed by the healthcare organization must cover skills such as interpersonal, self-management, and planning and organizing (Balakrishnan et al., 2018). Training activities should be focused on the development of employees rather than as an investment plan. The training programme should be designed on a periodical basis for incessant up-gradation of skills amongst individuals (Izumi et al., 2010; Vogel, 2016; Kneafsey et al., 2016). A qualified and trained workforce would be advantageous in the health sector for inter-disciplinary interactions, coordination across the hierarchy, effective and efficient management of resources, logistics, and supply chain (Sharma & Zodpey, 2011).

Measuring the intangible quality of health care services has become a duty of managers and hospital administrators. One parameter is patient satisfaction, which is a complex phenomenon that is also linked to patient expectations towards the facilities and allied services of hospitals (V.K. Singh, 2018). Patient satisfaction has evolved as well as knowledge of the results in the healthcare sector, which is also an imperative indicator for the quality of healthcare services and surveys. Patient satisfaction is one of the World Health Organization's (WHO) nine key indicators for measuring and quantifying the delivery of health services (Abid Hussian, 2019).

The hospitals intend to be endowed with the best medical facilities and management services for smooth operational activities. It is scurred by a staff consisting of doctors, nurses, paramedics, administrative, housekeeping, and much more (Surg, 2014). All the administrative staff of the hospitals are accountable and responsible for their tasks. Patients who are contented and impressed by the frontline staff will eventually develop trust in the services provided by the hospitals. The aptitude of the inpatient and outpatient departments is another important factor that often affects the success of the hospital (Tabish, 2011). Promoters frequently overlook the fact that these services are extremely profitable in terms of brand image building.

RESEARCH METHODOLOGY

Rationale and Objectives of the Study

The healthcare industry is considered a prodigious industry, both in terms of revenue and employment generation. It is a high-risk industry in which professionals have to practice zero negligence. The role of training has assumed paramount consequence in such a risk-driven industry. The rationale behind this research effort must be spelled out clearly. This will enable the readers to comprehend the importance and relevance of ES and training needs in the medical service vertical of hospitals. Everyone proclaims that human assets prove to be the paramount asset. On the other hand, there is a need to up-skill the employees to survive in the changing environment. Hospitals need to identify the skills required by their employees by performing for the detailed analysis, an employability skill set is created after conducting an intensive literature review, primary data collection, expert drawing, and using statistical tools. This employability skill set is further divided into 13 skill typologies in both generic skills and technical skills needed by the professionals to work in the medical service vertical. Hence, a research gap is apparent.

The primary purpose of this research is to develop and test a scale to assess the necessary competencies for professionals working in the MSV in Delhi/NCR hospitals. This study proposes to explore the obligatory skills required by frontline workers across the hierarchical level. So that they can identify their deficient skills and competencies, which are required to survive in a competitive business environment.

Date Source & Sampling Frame

A structured questionnaire has been designed and was further administered to 410 medical service professionals working in Delhi and NCR. A stratified random sampling method was used to acquire the data from healthcare professionals, and they were asked varied questions to identify their employability skill set. At a 95% confidence level and a 5% significance level, a standard formula for calculating sample size was used. According to Krejcie & Morgen (1970), for a target population of 10,700, the sample size must be 384 and above. For the study, the questionnaire was administered to 410 respondents, out of which seven had submitted incomplete forms and three were inclined on extreme sides. Therefore, the researcher has taken a final sample of 400 respondents.

A Sampling Frame to be considered for the Study:

- Private hospitals in Delhi/NCR would be used for the procedure.

- Multi-specialty hospitals with at least 200 patient beds are
- Hospitals with at least 50 employees (excluding doctors) are
- Hospitals with an annual revenue of at least Rs.50 lakh are eligible.
- Respondents with at least 10 years of experience are taken for this study Respondents must be at least diploma-holders and above for this

The above sampling frame was designed, taking a few things into consideration:

Since it was a difficult or impractical task to track down the entire population, the only method available was to sample the population. The sample is the envoy of the target population, thus it becomes imperative to pre-determine how to draw a sample size. Private hospitals are chosen as most of them have well defined hierarchies and often conduct training programmes at various levels, as compared to public hospitals. Moreover, the researcher has considered hospitals with huge infrastructure and revenue as training programmes require investment. The sample size of 400 respondents has been considered for this study. The researcher has distributed the sample as per the proportion given.

ANALYSIS AND INTERPRETATION

The data was analyzed using SPSS 23.0 and AMOS 23.0 versions. Normality and missing values of data were checked before performing an empirical analysis. The normality of data was checked at univariate and multivariate levels. For conducting normality tests, researchers used the MVN (Multivariate Normality) 1.6 version. Univariate normality was conducted using Shapiro-Wilk's and Anderson-Darling's normality tests. Whereas multivariate normality was performed using Mardia's and Henze-Zirkler's tests. Further, to check the normality, researchers used descriptive statistics for skewness and kurtosis.

Univariate, Multivariate Normality Test and Demographic Profiling of the Responding

As skewness is a measure of symmetry, its value must range between -2.0 to +2.0. As kurtosis depicts the end of a tail, its value lies between -3.0 to +3.0. As per the values obtained, they lie within this range, thus suggesting that the data is normally distributed. The outcome of the descriptive statistics is shown in table 1. Other tests like Shapiro-Wilk's and Anderson-Darling's were also conducted to confirm the univariate normality of data. Both the tests support the normality of data at a univariate level since the p-value is significant and less than 0.05 in each case. Thus, the null hypothesis was accepted. Results are shown in Table 2 and Table 3.

Table 1: Descriptive Statistic

	n	Mean	Std.De	Median	Min	Max	25th	75th	Skew	Kurtosis
PP	400	3.694	0.867	3.86	1	5	3.43	4.29	-1.252	1.103
BT	400	3.957	0.806	4	1	5	3.75	4.5	-1.585	2.74
FB	400	3.871	1.028	4	1	5	3.33	4.67	-0.92	-0.061
AU	400	3.38	0.929	3.75	1	5	3	4	-0.841	-0.17
IN	400	2.479	0.825	2.5	1	5	2	3	0.654	0.019
DO	400	2.819	1.183	2.5	1	5	2	3.75	0.202	-1.193
AS	400	3.585	1.132	4	1	5	3	4.33	-0.896	-0.189
ADMI	400	4.04	0.754	4	1.5	5	3.582	4.637	-0.787	0.357
STM	400	3.269	1.02	3.5	1	5	2.5	4	-0.683	-0.798
BA	400	3.953	0.879	4.1	1	5	3.6	4.6	-1.334	1.612
VAS	400	3.672	0.873	3.75	1	5	3.25	4.25	-0.584	0.035
SA	400	2.867	1.043	2.75	1	5	2	3.75	0.242	-0.99
CO	400	4.131	0.567	4.25	1.5	5	4	4.5	-1.51	2.748

Table 2: Shapiro-Wilk's Normality Test

	Variable	Statistic	p-value	Normality
1	PP	0.9777	0.4595	YES
2	BT	0.9717	0.2715	YES
3	FB	0.641	0.5542	YES
4	AU	0.823	0.6967	YES
5	IN	0.78	0.5345	YES
6	DO	0.596	0.7811	YES
7	AS	0.906	0.5452	YES
8	ADMIN	0.973	0.6752	YES
9	STM	0.69	0.4531	YES
10	BA	0.997	0.7911	YES
11	VAS	0.69	0.4143	YES

12	SA	0.721	0.6274	YES
13	CO	0.671	0.4321	YES

Table 3: Anderson-Darling's Normality Test

	Variable	Statistic	p-value	Normality
1	PP	0.408	0.3352	YES
2	BT	0.491	0.2102	YES
3	FB	0.341	0.2222	YES
4	AU	0.523	0.4567	YES
5	IN	0.48	0.3561	YES
6	DO	0.596	0.4671	YES
7	AS	0.606	0.5231	YES
8	ADMIN	0.713	0.5341	YES
9	STM	0.49	0.3811	YES
10	BA	0.697	0.5912	YES
11	VAS	0.321	0.2141	YES
12	SA	0.721	0.6234	YES
13	CO	0.521	0.4321	YES

To check the multivariate normality of data, Mardia's and Henze-Zirkler's tests were conducted. Again, it was observed that the p-value was significant and less than 0.05. This supports that data is normally distributed at the multivariate level. Hence, the null hypothesis was accepted. Results are shown in Table 4 and Table 5. It demonstrates that the data is normally distributed both at the uni-variate and multivariate levels. For further analysis, the researcher used statistical software like SPSS 23.0 and AMOS 23.0 to achieve the objectives of the study.

Table 4: Mardia's Multivariate Normality Test

g1p	:	0.09114042
chi.skew	:	0.7595035
p.value.skew	:	0.9437932
g2p	:	8.105738
z.kurtosis	:	0.09346006
p.value.kurt	:	0.9255381
chi.small.skew	:	0.8379339
p.value.small	:	0.9332914

Table 5: Henze-Zirkler's Multivariate Normality Test

HZ	:	0.2856007
p-value	:	0.9146336
Source: The authors		

Table 6, which exhibits the demographical representation of the respondents considered for the study, it shows that most of the respondents lie between the 35 to 42 age group and are employed either at the middle or lower level in the organization. They have more than 10 years of experience, which assisted the researcher in gathering feasible and reliable responses.

Table 6: Demographic Traits of Respondents

Characteristic		Number	Percentage (%)
Gender			
Male		286	71.5
Female		114	28.5
	Total	400	100
Age (years)			

21-28		71	17.75
28-35		126	31.5
35-42		165	41.25
Above 42		38	9.5
	Total	400	100
Highest Degree Earned			
Post-Graduation		62	15.5
Graduation		233	58.25
Others (diploma holders, etc.)		105	26.25
	Total	400	100
Experience			
Above 3-5 years		74	18.5
5-8 years		116	29
8-11 years		138	34.5
Above 11 years		72	18
	Total	400	100
Organizational Level			
Top Level		22	5.5
Middle Level		143	35.75
Lower Level		235	58.75
	Total	400	100

Exploratory and Confirmatory Factor Analysis

The researcher used SPSS 23.0 to perform EFA (Exploratory Factor Analysis). Both the varimax rotation and the promax rotation are used to identify a minimum number of factors showing a maximum portion of the variance. As shown in Table 8, 54 items measured on a Likert-scale were converged onto 13 factors. Moreover, to assess the suitability of the data, the Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity were used. It is also useful for evaluating factorability. The estimated value of KMO is greater than 0.07. It shows that the data is sufficient to run EFA and the significant value of Bartlett's Test falls within the ranges, indicating that the co-relational matrix is not an identity matrix (Table 7). (Leech et al., 2005; Tabachnick & Fidell, 2001 & 2007; Raza & Hanif, 2013; Ali, Raza, & Chin-Hong, 2015; Schuster, 2016).

Table 7: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.871
Bartlett's Test of Sphericity	Approx. Chi-Square	11525.633
	Df	1431
	Sig.	.000

After performing EFA, we got thirteen factor loading indices as depicted in Table 8 All the values of all the variables are higher than 0.65 and are significant too. According to Bowen and Guo (2011), 0.4 is also an acceptable value.

Table 8: Exploratory Factor Analysis (n=400)

	BT	PP	FB	SA	AV	IN	AS	BA	ADIMN	STM	DO	VAS	CO
Cronbach alpha	0.897	0.857	0.879	0.892	0.785	0.896	0.72	0.785	0.881	0.886	0.842	0.874	0.715
% of Variance	19.3	7.44	6.095	4.658	3.991	3.265	2.818	2.417	2.126	2.269	1.87	1.82	1.285
Cumulative %	19.3	26.74	32.84	37.5	41.49	44.75	47.57	50	52.56	54.38	56.25	58.07	59.36

F11	.757			
F12	.817			
F13	.761			
F14	.805			
F15	.698			
F16	.572			
F17	.792			
F21			.792	
F22			.830	
F23			.764	
F24			.674	
F31				.867
F32				.758
F33				.863
F41		.840		
F42		.864		
F43		.847		
F44		.704		
F51				.702
F52				.706
F53				.679
F54				.638
F61		.868		
F62		.898		
F63		.848		
F64		.676		
F71				.810
F72				.645
F73				.626
F81				.653
F82				.660
F83				.642
F84				.673
F91		.828		
F92		.785		
F93		.828		
F94		.782		
F110	.746			
F210	.740			
F310	.711			
F410	.897			
F510	.727			
F111			.735	
F211			.771	
F311			.964	
F411			.443	
F112		.765		

F212	.840	
F312	.809	
F412	.767	
F113		.719
F213		.759
F313		.723
F413		.741

Table 9 the description of skill-base job profiling. The following definitions indicate the skills and their associated characteristics.

Table 9: Description of attributes

Factors	Description
Fire-brand	This skill requires an unconventional thinking. They are usually assertive in their dealings and believe in an explicit transaction of information. They develop a strong network using both verbal and nonverbal techniques.
People-Person	These skills deal with active and empathic listening which helps in building greater persuasion. Individuals with these abilities are proficient in speaking and excel at relating materials, demonstrating their ability to think clearly and handle any situation.
Auditor	This competence is primarily concerned with understanding of how to operate complex software such as Microsoft Office. It also deals with the effective knowledge of writing emails and operating internet for various reasons.
Fireball	This skill in particular is like a proxy setting which maintains data integrity of various levels. Individuals with this kind of expertise ensures that information is retrieved, retained, and transferred without the use of malware or Trojans.
Autopilot	Individuals possessing such skill set, allows people to maintain a high level of timeliness, etiquette, and loyalty. These people believe in taking accountability on the task allocated to them. They believe in continuous learning based on their and other peoples experiences.
Dove	People with this skill believe in moving in a specific direction. They believe in having role clarity which gives them satisfaction while working. They are adaptable to new roles and believe in responsibility sharing with their colleagues.
Initiator	Individual possessing such competencies are leaders which have an ability to successfully drive their team. They achieve elevated corporation from their team. They are participative in nature and believe in sharing knowledge with the team.
Buoyant	Individuals which have this trait are optimistic & enthusiastic. They are sensitive to other people's emotions and believe in looking after others. This skill is about handling patients tactfully and encouraging them by building a great rapport.
Amenable	People who have this competence make excellent mentors because they take ownership of their responsibilities, especially in times of crisis. They act as a peacemaker and mediate the conflict.. These people are known for handling contingent's situation.
Magnetic	These people believe in stimulating change by counseling others. They don't resist change; instead, they demonstrate a higher level of cultural and linguistic adaptation. This in turn makes them socially interactive.
Value-added Seller	These sellers are intelligent and believe in collaborating to reach to a solution. They begin by diagnosing the issue and checking firsthand facts in a systematic manner. Their curiosity empowers them to handle the complex situation.
Assiduous	These are the individuals who have a higher level of self-assurance. Their ace in skills like time management, anger management, abiding by the laws and believes that it is the responsibility of an individual to elbow grease their self-improvement on a timely basis.
Administrator	These are task oriented people and have sharp-set for numbers and records. They are concerned in the allocation of inventories and equipment, as well as financial resources.
Stimulator	This is the defense, which enable people to prioritized work and proactively plan the things before an event occurs. This skill is possessed by those who are extremely motivated and believe in constant growth.
Band-Aid	It is a quick healing skill and comes into operation as the reaction to any situation. People with this competence work in emergency situations, deploying contingency plans successfully.

Starry-eyed	They are the visionaries who believe in making decisions based on critical analysis of a situation. They are the logic holders and believe in facts and figures.
Cogent	These are the people who are consistent, credible and inflectional. They persuade people to accept an argument or a reason by clearly expressing it and believe in performing deductive reasoning using instances either from law or other credible sources.

After extracting factors from EFA, the researcher performed CFA using AMOS 23.0 version to test the covariance structure of all latent variables. First, the research instrument was checked with Cronbach Alpha to secure reasonable item coefficients. In addition, to assess convergent validity, measures such as average shared variance (ASV) and maximum shared variance (MSV) were estimated. Furthermore, for each latent variable, composite reliability (CR) and McDonald Construct Reliability (MaxR(H)) were estimated because they are more consistent forms of reliability than Cronbach coefficient alpha. (Hancock & Mueller, 2011; Lin & Lee, 2005; Molina, Llorens Montes, & Ruiz-Moreno, 2007; Raza, Qazi, & Umer, 2016).

Table 10 shows the composite reliability (CR) and average shared variance (AVE) of all the thirteen latent variables. It indicates that the value of CR is greater than 0.70 and the value of AVE is greater than 0.50 for all the latent variables. It demonstrates respectable construct reliability and convergent validity (Byrne, 2010). Moreover, discernment validity between all the latent variables is also established (Table 10) (Fornell & Larcker, 1981). Confirmatory Factor Analysis (CFA) approaches to scale reliability estimation and with formative indicators (Raykov & Marcoulides, 2006). It is also used in the process of scale development to examine the latent structure of a questionnaire. The higher-order factor analysis is conducted to analyze the conceptual amount of interrelationships among the factors in the initial stage using standardized estimates.

Table 10: Validity and Reliability

	CR	AVE	MSV	MaxR (H)	BT	pp	FB	SA	AV	IN	AS	BA	ADIMSTM N	DO	VAS	C
BT	0.735	0.684	0.510	0.863	0.696											
pp	0.898	0.564	0.318	0.934	-0.021	0.751										
FB	0.888	0.615	0.438	0.958	-0.030	0.381	0.785									
SA	0.897	0.688	0.241	0.899	-0.023	-0.125	-0.153	0.829								
AV	0.829	0.676	0.556	0.876	-0.022	0.269	0.278	-0.397	0.822							
IN	0.883	0.653	0.547	0.900	-0.102	0.159	0.216	-0.046	0.008	0.808						
AS	0.874	0.636	0.484	0.383	0.030	0.024	-0.289	0.076	-0.027	-0.078	0.797					
BA	0.858	0.602	0.373	0.888	0.021	0.280	0.502	-0.290	0.506	0.134	-0.195	0.776				
ADIM	0.846	0.579	0.499	0.986	0.062	0.290	0.515	-0.347	0.446	0.112	-0.153	0.577	0.761			
N																
STM	0.783	0.776	0.241	0.886	-0.059	-0.171	-0.217	0.491	-0.317	0.003	0.107	-0.373	-0.402	0.690		
DO	0.879	0.709	0.318	0.988	-0.017	0.564	0.425	-0.138	0.207	0.110	-0.120	0.273	0.251	-0.168	0.842	
VAS	0.785	0.678	0.438	0.793	0.003	0.314	0.662	-0.335	0.468	0.130	-0.224	0.538	0.632	-0.362	0.430	0.691
CO	0.783	0.675	0.413	0.884	0.037	-0.054	0.032	-0.032	-0.015	0.069	-0.093	0.014	0.067	-0.113	0.013	0.055

Figure 1 shows the measurement model, which is comprised of fifty-four indicator variables and thirteen latent variables. It was found that all the indicators are significantly related to latent variables.

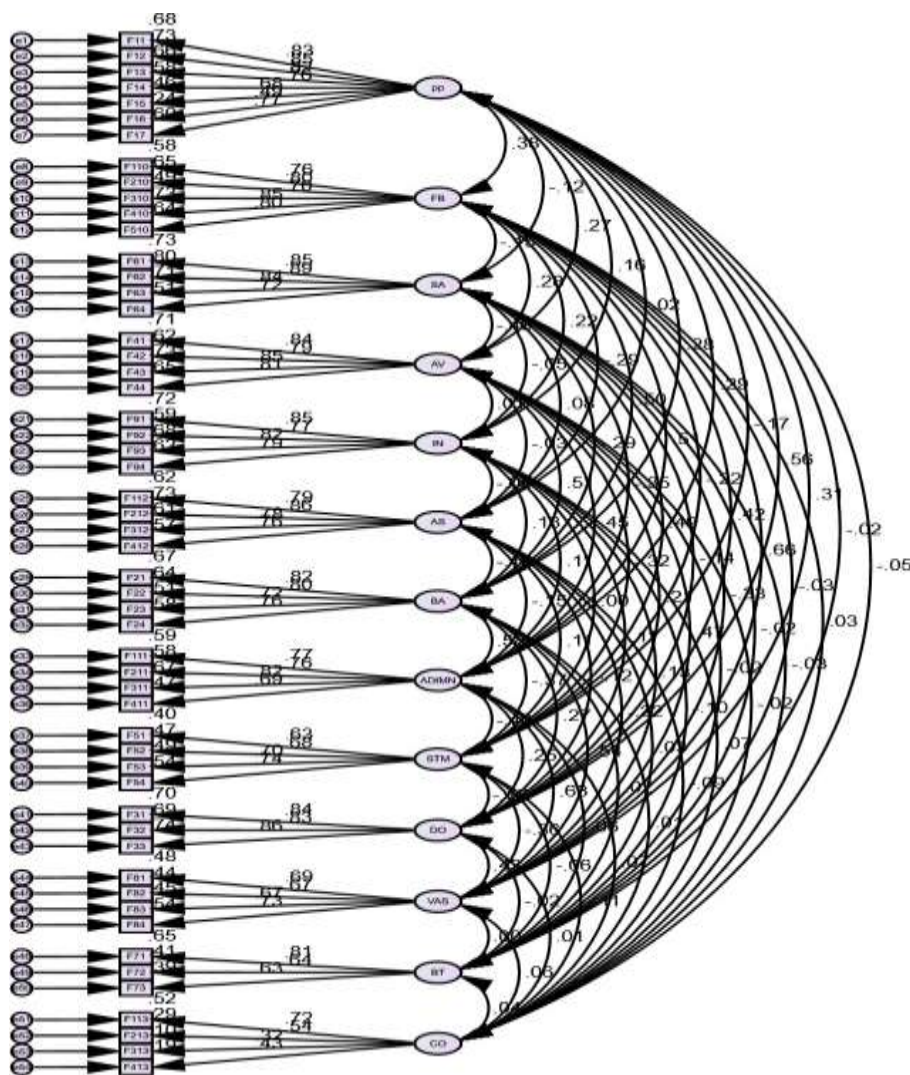


Figure 1: Confirmatory Factor Analysis (Measurement Model)

Moreover, the values of relative Chi-square, comparative fit index, squared root of the average, Tucker-Lewis index, and root mean square error of approximation were within an acceptable range. As a result, all of the obtained values indicate a satisfactory model fit with acceptable factor loadings, indicating the effective CFA. Table 11.

Table 11: Model Diagnostics

Chi-square(χ^2)	1777.530
Degree of freedom (df)	1299
P-value	0.000
CMIN/DF	1.368
CFI (comparative fit index)	0.955
TLI (Tucker-Lewis index)	0.951
RMSEA (root mean square error of approximation)	0.030
RMR (squared root of the average)	0.053

RESULT AND DISCUSSION

The result reveals that all the thirteen factors extracted are mapped against the variables identified from the literature. Communication, ICT (Information Communication Technology), team-work, planning & organizing, conceptual & analytical, critical & problem solving, all these are the broader aspects of employability skills which are the true representatives of buoyant, people-person, fireball, starry-aid, auditor, initiator, assiduous, band-aid, administrator, stimulator, dove, value-added seller, and cogent.

Thirteen factors have respectable factor loadings (more than 0.75) that allow the researcher to make such an inference. Dove, People-person, Auditor, and Fireball should be considered as a major part of their content development in recruitment, selection, and training programs, as they showcase maximum loadings, demonstrating their significant contribution in up-skilling the frontline workforce for better patient satisfaction and the overall brand image of the hospitals. The model diagnostics also reveal a satisfactory model fit in terms of chi-square, CFI, TLI, RMSA, and Squared Root of the Average, confirming the effectiveness of CFA. This indicates that the model is both valid and steady. Furthermore, the outcome reveals that the measurement scale utilized is robust and can be used for future research. The R-square values were likewise within acceptable limits, indicating that the scale could be used for test-retest analysis. Correlation analysis revealed considerable significant associations between the diverse dimensions of employability skills previously studied (Table 12). There was no statistically significant or negative relationship discovered in either of the correlations. This means that a change in one dimension for the better has a good effect on the other.

Table 12: Correlations

Correlations													
Pearson Correlation	people person	Buoyant	Fireball	Auditor	Initiator	Dove	Assiduous	Administrator	Stimulator	Band aid	Value added seller	Starry aid	Cogent
People Person	1												
Buoyant	.234**	1											
Fireball	.487**	.237**	1										
Auditor	.236**	.452**	.181**	1									
Initiator	.136**	.304**	.136**	.260**	1								
Dove	.106*	.268**	.121*	.365**	.412**	1							
Assiduous	.006	.041	.009	.002	.065	.018	1						
Administrator	.259**	.438**	.358**	.387**	.274**	.284**	.023	1					
Stimulator	.150**	.110*	.100*	.004	.004	.051	.095	.105*	1				
Band aid	.340**	.430**	.375**	.255**	.175**	.137**	0.0004	.550**	.201**	1			
Value added seller	.250**	.504**	.223**	.402**	.326**	.314**	.075	.539**	.090	.458**	1		
Starry aid	.018	.163**	.105*	.019	.084	.061	.014	.186**	.073	.253**	.128*	1	
Cogent	.034	.014	.013	.008	.148**	.056	.006	.074	.060	.052	.075	.045	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

CONCLUSION

The main noteworthy takeaway of this study is that the researcher extricates an encyclopedic list of employability skills sets needed for frontline workers in hospitals in Delhi/NCR. It shows that versatile employees contribute more to the growth and prosperity of an organization. Various attributes such as dove, people-person, auditor, fireball, cogent, and value-added seller exhibit maximum contribution in enhancing hospitals' productivity and effectiveness, patients' satisfaction, and quality services. Each positive variation in one of the variables induces a corresponding positive variation in the other. Human resource practitioners, academics, and researchers will benefit from this research.

MANAGERIAL IMPLICATIONS

This study is a significant step towards understanding the minimum skills required by frontline workers to get employed in hospitals. The study is helpful to both employees and human resource practitioners in the healthcare industry. Employees can identify and work on their shortcomings. Consequently, this will assist human resource professionals to check the trainability of the workforce before designing a training program. Managers can use these parameters when recruiting and selecting employees, analyzing training needs, and deciding on a compensation package. This will help them curb the problem of recruiting the right candidates for the right job and other retention issues.

LIMITATIONS

There are several limitations to the study. Firstly, the researcher only considers one vertical of the healthcare industry; therefore, this study cannot be generalized to the entire industrial and non-industrial service sector. Medical Training, Medical Education, and Medical Research are the other major verticals that offer a lot of potential for training and development. This study is limited to the private multi-specialty hospitals located in Delhi and NCR. Due to sample limits, the study excludes government, semi-government, defense, and charitable hospitals. The study's conclusions are based on what the people who took part in the study thought, which mostly had to do with typical human flaws.

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Digital inequalities at high schools in Thailand: A survey-based exploration leading to expert-backed bridging strategies

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ABSTRACT

Purpose: The purpose of this research is to explore the accessibility of online education for high school students in Thailand. It especially focuses on identifying the inequalities among Thai students in terms of availability of IT hardware, internet access, and IT skills by comparing the results of surveys of students in urban areas with those from students in rural areas within Thailand. Based on these findings and input from experts in the Thai education system, strategies to reduce digital inequalities are presented.

Design/methodology/approach: To fulfill the objectives of this research, primary data is collected through online surveys with Thai high school students in order to explore digital inequalities. Additionally, semi-structured interviews with experts on Thai education are conducted in order to evaluate the findings from the students' survey responses and to generate bridging strategies. Moreover, a regional comparison based on findings from research conducted in neighboring countries will enable an analysis of the findings in an international context.

Findings: This research provides information and insights into digital inequalities existing in the Thai education system. It reveals insights into the availability of IT hardware and access to the internet for online education, as well as the IT skills of high school students across Thailand. It highlights the differences in these areas between urban and rural locations within the country. Based on these findings, expert-backed recommendations are provided to bridge these inequalities.

Originality/value: The demand for IT in education is increasing significantly. Recent developments, such as the COVID-19 pandemic, have accelerated such trends. These rapid evolutions need to be explored regularly in order to inform appropriate intervention strategies. Therefore, this research contributes to academia and enhances the ability of stakeholders and decision-makers in Thailand's education sector to respond effectively to the increasing digital inequalities experienced by Thai high school students.

Keywords: Digital Inequalities, Digital Divide, IT Hardware Accessibility, IT Skills, High School Students, Thailand.

INTRODUCTION

The importance of the usage of IT in education has increased significantly in the last few years. This importance reached its highest point so far during the COVID-19 pandemic in which the classical form of onsite teaching had to be adapted into online teaching without prior notice and in the shortest possible time. This led to issues not only in the Thai education system but also globally. (Imsa-ard, 2020; Satoshi, 2022) The Thai administration initiated intense programs more than ten years ago to improve access to IT for students. This program was stopped following the coup d'état in 2014. (Todd, 2015; Tubplee, 2019) Access to IT is of high importance in the knowledge economy. Limitations caused by differences within the society of a country, for example, lead to disadvantages and inequalities—a so-called 'digital divide.' (Giebel, 2013)

The Thai educational system is managed, organized, and overseen by the Ministry of Education (MOE). The ministry defines the national educational standards and aims to provide education for every age group of Thai people. To do so, it has divided students into three main groups (Phumphongkhochasorn et.al., 2021):

- Pre-school education (optional, starting from the age of three years)
- Primary school education (6-year program known as "Prathom", Thai classes P1 to P6)
- Secondary school education / high school education (6-year program known as "Mattayom", Thai classes M1 to M6)

Besides the MOE's aim to teach Thai students all relevant knowledge in the context of Thai culture, teaching technology and especially IT-related skills have been part of the curriculum for several years. Such activities have especially been clustered as part of a program called 'Thailand 4.0'. It divides the IT skills of people into three groups in order to develop their skills according to their capabilities and needs: (Phumphongkhochasorn et.al., 2021; Sombunsin and Wannasri, 2022)

1. IT skills at a beginner level
2. IT skills at an intermediate level

3. IT skills at an advanced or expert level

To reach the aim of increasing the awareness, usage, and access to IT in Thai classrooms, the MOE allocated a budget and specific materials and schooling for students and teachers. Critics have raised concerns, as the success of such programs is difficult to evaluate and monitor. In particular, the very different systems, structures, cultures, and attitudes among diverse schools in the various Thai regions seem to be a challenge. (Boonmoh et.al., 2021; Sitthisomjin et.al. 2020).

The need for IT in education achieved new relevance at the beginning of 2020. When the COVID-19 virus began spreading worldwide and the pandemic situation was declared, the MOE needed to act quickly in order to limit the circulation of the virus among students and teachers. An initial decision was made to delay the beginning of the new school semester in April 2020. Soon it became obvious, however, that the pandemic would further worsen and that stopping all teaching activities could not be the only solution. The MOE developed a program using the slogan “Stop school but not stop learning (โรงเรียนอาจหยุดได้แต่การเรียนรู้หยุดไม่ได้)”. The main intention of the program was to switch from onsite teaching to online learning. Already at this very early stage, critics announced worries about the efficacy of online education and the learning outcomes of students. (Satoshi, 2022)

Today, in September 2022, the number of COVID-19 infections is at a low level and the pandemic seems to be slowly coming to an end. Therefore, this research work explores these concerns by raising the following research questions: Do Thai high school students have the required hardware and the necessary IT skills to participate sufficiently in online learning? What kind of recommendations can be given to improve online learning for Thai high school students?

In the first section, this research work summarizes the relevant literature about the digital divide in Thailand. Therein it provides the framework of the research. It describes the two ways to generate primary data to better understand the phenomena: First, by performing an online survey with Thai high school students. And, second, by conducting expert interviews to evaluate and comment on the findings from the student survey. The findings are summarized and are used as a basis to answer the research questions. In the final section, recommendations and an outlook is provided.

LITERATURE REVIEW

The Southeast Asian country Thailand has a total population of 69.6 million people. Half of its population lives in urban areas, such as Bangkok and Nonthaburi City. The country has a literacy rate of 94%. 78% of the total population uses the internet. 95% of Thai students complete primary school. 15% of children younger than 14 years are employed. In 2021, the formal Thai school system including primary, secondary, and higher education had a total of 12.5 million students in public and private institutions. 4.3 million of these students are high school students. (National Statistical Office, 2022; O'Neill, 2021; World Bank, 2022)

IT usage in Thai high school education prior to COVID-19

The first attempts to implement national programs to increase the usage of IT in classrooms were initiated in the year 2012. The government of the former Thai prime minister, Ms. Yingluck Shinawatra, began a program called ‘One-Tablet-Per-Child’. The aim was to raise access to IT devices (here: tablets) for students. This was done by providing around 800,000 tablets with learning materials for the main subjects to students all over the country. (Tubplee, 2019; Viriyapong and Harfield, 2013). The program had its share of supporters, but critics raised concerns that the very different IT skill levels of the various age groups and different regions were not accounted for. There were serious concerns that students were overburdened and that increased IT usage could be unhealthy for students. Budgets used for this program could have been used more efficiently at other points, critics highlighted. In 2014 the government changed due to a coup d’état. With this change in the administration, the ‘One-Tablet-Per-Child’ program was ended. (Tubplee, 2019; Todd, 2015).

New approaches were made again in 2016. The new Thai administration initiated a program called ‘Thailand 4.0’. This nationwide program was aimed not only at students but at all kinds of sectors within the country. It developed and defined actions for the years from 2017 to 2021 and provided budgets for technology implementation and schooling. (Phumphongkhochasorn et.al., 2021; Wittayasin, 2017) The usage of technology at schools increased. Classical blackboards were often replaced by interactive devices. The use of computers and tablets for teaching also increased. (Puttimanoradeekul, 2021)

IT usage in education in Thai high school education during COVID-19

During April and May 2020, the Thai MOE prepared to adapt education during the COVID-19 pandemic. The digital readiness of the education system was analyzed and digital TV channels were certified to broadcast educational content. In the following months, online learning and educational TV channels started their work. (Satoshi, 2022) An exploration of the student’s perception of this sudden ‘forced change’ from onsite to online learning came as the result, that students think online learning “did not encourage sufficient access to the education” and “did not think that their instructors could organize the lessons efficiently”. (Imsa-ard, 2020) At the same time, this research stated that students, in general, are willing to perform online learning, even though technical problems occur, and disruptions and demotivation were common. A majority stated they preferred learning onsite (face-to-face classroom).

The COVID-19 pandemic hit the country and the Thai education system five years after the end of the ‘One-Tablet-Per-Child’ program. The MOE organized actions to switch from onsite teaching to online teaching. The need for IT devices and IT skills among students and teachers increased significantly. Budgets and extra schooling programs were implemented to react swiftly. Additionally, teaching via television was provided to support the individual online teaching of the schools. The increased demand for IT devices led to promotions from IT companies. Nevertheless, low-income households especially encountered issues with covering the new expenses. (Boonmoh et.al., 2022; Nantha et.al., 2022, Tuangrattanaphan, 2021) Seangsawang and Wongprasit (2021) analyzed guidelines for primary school administrators in one Thai region and came to the conclusion that “most parents do not have the technological tools for their children to study online because they do not have enough money”. Nuankaew et al. (2021) explored the impact of COVID-19 on higher education in Thailand and found out that “the digital technology cannot catch up with the people, due to the expenses hindering the needs to find the proper learning tools and materials for students to perform effectively. In addition, the important problem is the internet network system that does not cover many rural areas.”

Eliyana and Ardiyansah (2021) investigated online teaching in rural areas of Thailand and found that “[only] a portion of all grade school students in rural areas are outfitted with a device and decent internet connection”, leading to disruptions in the learning process for many students.

Besides the availability of required IT equipment, IT skills, and internet, Somsathan and Sanjaiprom (2021) stress the fact that matching teaching material needs to be available and teachers need to be schooled to perform this form of teaching, as otherwise “teachers will be unable to deliver and design engaging and effective eLearning lessons.” Espino-Díaz et al. (2020) analyzed the impact of COVID-19 on educational staff and highlighted the “emotional exhaustion, stress, anguish, or anxiety due to confinement and distance education” on the teacher’s side, and added that “excessive bureaucratic tasks, unclear instructions, lack of support in teleworking, and lack of technical means were the main problems pointed out by teachers.” Wongjamnong et al. (2021) explored the readiness for online teaching of Thai primary school teachers and concluded that they “are quite not ready with online instructional practices. (...) Teachers need to reskill or upskill in the field of educational technology.”

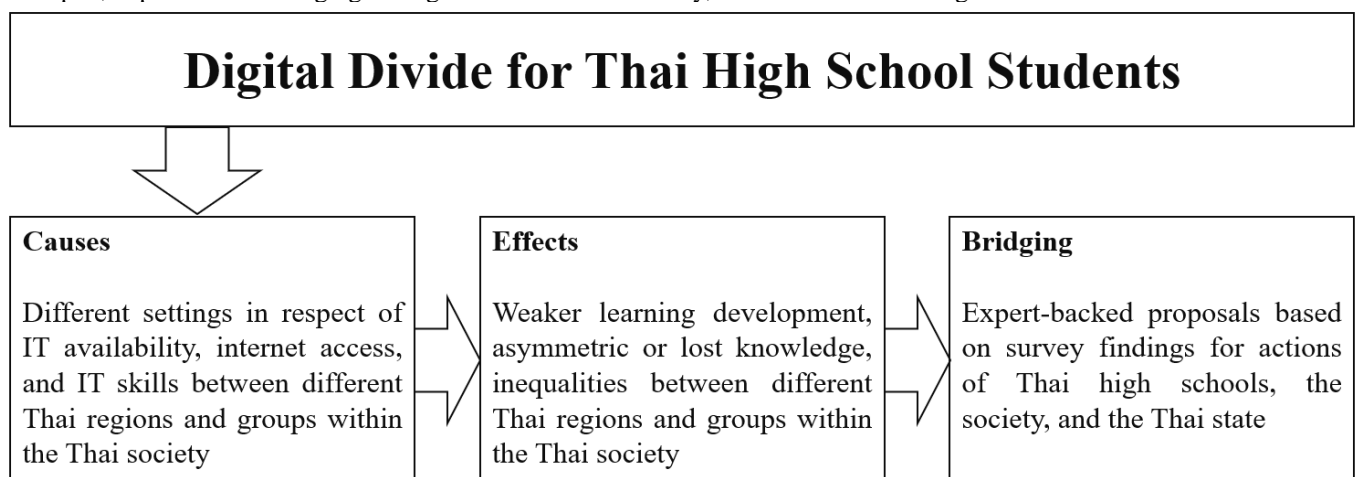
Giebel (2013) describes access to Information and Communication Technologies (ICT) as crucial in the knowledge economy. IT applications, such as social media, are useful for knowledge-sharing activities (Chen et al., 2014) and support the creation of facilitating learning environment (Ractham et al., 2012). Limitations to ICT lead to disadvantages referred to as the digital divide. Digital divides can be caused by major differences in the society of a country and insufficient access to ICT or to information in general. The results are weak economic growth and low development rates, an asymmetric localization, or even the loss of knowledge and low innovations. Ways to bridge digital divides can be achieved by national strategies or open-source solutions and open innovation management.

These digital divides resulting from differences in society and from unequal access to IT among Thai high school students are analyzed in this research work. The methods of this approach are described in the following section.

METHODS

Framework of research

Based on the model of the digital divide from Giebel (2013), this research explores different perspectives on the digital divide among high school students in Thailand. It analyzes the causes resulting from different settings within the various Thai regions and within different groups in Thai society. Here especially the access to the needed IT equipment, the availability of sufficient internet connections, and the level of IT skills are explored. The findings are analyzed and the effects are described. Based hereupon, expert-backed bridging strategies are discussed. Finally, recommendations are given.



Source: own figure, partly derived from Giebel, 2013).

Figure 1: Causes, effects, and bridging of the digital divide of Thai high school students.

Primary data from surveys with Thai high school students

To explore the inequalities experienced by Thai high-school students, an approach using case studies has been identified as an ideal method to gain data in order to answer the research questions. Yin (2009) describes case studies as a method “that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.” These described framework conditions are given in this research: A sudden increasing importance of IT in education being the contemporary phenomenon, with a focus on high-school education in urban and rural Thailand being the deepened real-life context, and the research question exploring the boundaries of this phenomenon within this context.

To receive information about the latest status of the phenomena, this research generated primary data from Thai high school students. The peer group has been defined as follows:

- High school students (Thai grades M1 to M6)
- In Thailand
- Studying at private and governmental schools
- Age 11 to 19 years

The research questions have been broken down into 19 separate questions, some with sub-questions. Using these questions and some additional, voluntary statistical questions for later evaluation, an online questionnaire has been set up and shared via social media and teacher networks with high school students. Between April and July 2022 students were able to respond to the survey.

In total, 368 surveys have been filled, from which 219 (= 60%) came from Thai urban areas and 92 (= 25%) from Thai rural areas. 57 students (= 15%) opted to not define their location.

Table 1: Received surveys from Thai high school students broken down by location.

	Quantity	%
High school students from		
Urban Areas	219	60%
Rural Areas	92	25%
Unclear Areas (undefined)	57	15%
Sum	368	100%

Source: This study.

Primary data from expert interviews on high school education in Thailand

In order to evaluate the findings from the surveys with students, expert interviews have been performed. These interviews on the one hand help to evaluate and interpret the survey data. On the other hand, they provide a different perspective of the online learning process, as several teachers involved in online teaching were able to share their expert opinions, experiences, and knowledge.

The experts have been selected based on their ability to provide a wide range of expert knowledge: Younger teachers and teachers who just entered retirement after COVID. Government teachers, as well as private teachers, have been interviewed. Teachers from urban areas were as well part of the interview series, as were teachers from rural areas. Additionally, one professor for Learning Sciences and Education has been interviewed, in order to receive an academic perspective on these findings and to receive information about teachers’ experience in the learning process during COVID-19 (‘Student teachers’).

The interviews were conducted online. The teacher could choose a preferred language (Thai, English, or German). One week prior to each interview, the interviewee received the key data from the survey and a list of questions. The interviews were performed by one or two researchers and have been recorded for documentation and later evaluation. An anonymous list of interview partners can be found below.

Table 2: Anonymous list of expert interviews including their location, gender, interview language, and main contribution.

Nr. Expert Interview (EI-xx)	Professional Background of Expert:	Region	Gender	Interview language	Providing Expert knowledge, especially in the fields of:
EI-01	Government school teacher for German and English (retired after COVID)	Bangkok	F	GER	<ul style="list-style-type: none"> • Online teaching experience during COVID at a government school • Experience as an older teacher dealing with IT
EI-02	Government school teacher for science	Rural Southern Thailand	F	TH	<ul style="list-style-type: none"> • Online teaching in a rural area
EI-03	Government school teacher for science	Suburb of Bangkok	M	TH	<ul style="list-style-type: none"> • Online teaching experience during COVID at a government school
EI-04	Government school teacher for German	Bangkok	F	GER	<ul style="list-style-type: none"> • Online teaching experience during COVID at a government school
EI-05	Professor for Technology and Information for Learning Sciences and Education	Bangkok	F	ENG	<ul style="list-style-type: none"> • Academic perspective of online teaching • Experience with teachers in the learning process during COVID
EI-06	Private teacher and owner of language school for German language in Thailand	Bangkok	F	GER	<ul style="list-style-type: none"> • Only teaching experience during COVID as a private teacher/tutor
EI-07	Government school teacher for Mathematics	Bangkok	F	TH	<ul style="list-style-type: none"> • Online teaching experience during COVID at a government school

Source: This study.

RESULTS

Using data from the student survey and the evaluations of experts, the following results can be summarized. The results are backed by quotes from expert interviews and by statements made in the commenting sections of the student surveys.

IT availability for Thai high school students

Nearly two-thirds (62%) of Thai high school students had access to desktop computers or notebooks (including laptops). The remaining students had sometimes (21%) or no access (15%) to these IT devices. These results differ when analyzing the results from the different regions within the country: In urban areas, even 76% had access to computers but only 39% in rural areas. A significant difference. The access to printers (44%) and scanners (36%) is much lower.

“The school and students are not ready for an online class because lots of students cannot afford the needed IT devices.”

(Government school teacher, Interview # EI-07)

Access to smartphones (including tablets) is more common. 90% of students in urban areas and 66% in rural areas had access to such IT devices. (Average for the complete country: 82%). Only a small group (8%) had no access at all. One expert stresses the fact, that sometimes a smartphone is available but it needs to be shared between the complete family or between siblings. Here situations occur, in which students cannot join online teaching, as the device is 'occupied' by a different family member.

“Often families had only one device. The parents and the students needed to share it.”

(Professor at the Faculty of Learning Sciences and Education, Interview # EI-05)

When consulting experts, they confirm that nearly all students had access to smartphones. Nevertheless, they stress the fact that they are inferior to online learning: The screens do not offer the same quality to deal with information as a computer and the possibility to work on assignments is limited. At the same time, they are offering advantages compared to computers: A lower price, better mobility, easier to use and most often lower costs.

“Computers are much better for online learning. The screen on smartphones is just too small. Computers are offering a big screen and it is just superior and offers more interesting opportunities. Smartphones are more practical to use for students. They can use them everywhere. They do not need much space. And in any case, they had them already and did not need to buy them extra for online learning.”

(Government school teacher, Interview # EI-01)

Nearly half (46%) of Thai high school students needed to invest in new IT equipment, such as computers or smartphones, during the pandemic. More investments were made in urban areas (47%) than in rural areas (40%). Only one quarter (25%) received financial support, for example from the government or school, for such investments.

“Online learning is more expensive than usual. This stresses me.”

(High school student, 18 years old, M6, no region defined, survey answer # 7)

One expert raises health concerns in connection with the long-term usage of smartphones, as the blue light of the screens may harm the eyes of students if used for more than one hour.

“The blue light emitted by smartphones is not good for the eyes of the students. They should not be used longer than an hour otherwise it could harm the health.” (EI-05)

(Professor at the Faculty of Learning Sciences and Education, Interview # EI-05)

A vast majority (83%) of students reported good internet quality in their homes. The urban area (88%) had slightly more positive answers than the rural areas (77%). Only a very small group of students (3%) had no access at all to the internet. Asking about the internet quality in schools, the results are not as positive: Only 40% report good quality. More than half (52%) of the students described the internet quality in their schools as being weak. In an open question, students had the chance to mention places which they go to in order to use the internet if there is no internet available at school or at home. The place most often mentioned, were the house of friends or other family members, cafes, malls, and restaurants. Moreover, students often stated that they change to mobile internet on their phones, such as 3G or 4G.

“The worst thing during COVID-19 was online learning because sometimes the internet was not good and we could not go to school.”

(High school student, 17 years old, M4, refused to define the region, survey answer # 12)

Experts confirm that the internet quality in most cases was sufficient and major interruptions only rarely occurred. This especially can be stated for urban areas. Nevertheless, some teachers from rural areas reported weak internet connections. A nationwide issue seems to be the internet signal or WiFi network within school buildings. Some teachers commented on regular temporary electricity cut-offs, especially in the rainy period, interrupting online learning.

“We very occasionally had problems with the internet quality. In these cases, we need to wait. But it did not happen often.”

(Government school teacher, Interview # EI-01)

“The internet quality is a problem for both teacher and student. It is not stable because my school is located in a very rural area next to the forest. It is less participation in class if compared with onsite.”

(Government school teacher, Interview # EI-02)

Online learning efficacy of Thai high school students

Half (50%) of Thai high school students are of the opinion that they did not learn better before the COVID-19 pandemic. There is no major difference in this opinion between urban areas (50%) and rural areas (54%). When asked about their participation in class, only 36% of the students think they were participating more when being in onsite classes. The majority (55%) was not of this opinion.

"The worst thing during COVID for me? I did not understand the teaching!"

(High school student, 15 years old, M3, Nakhon Si Thammarat Region, survey answer # 26)

Experts highlight that the participation of students during class decreased. Good students who used to participate in onsite classes also did so in online classes. Weaker students partly used the chance of online teaching to hide by turning off the camera and microphone and were not anymore reachable for the teachers. Especially, the usage of the camera has been stressed by nearly all experts. There seems to be a difference between classes in which the students knew each other personally before starting online classes. These students felt more comfortable to interact online, participated more, and were not as shy. A finding from many interviews is that teachers after COVID-19, they see advantages from a mix of onsite and online teaching. Such a hybrid model is partly seen as even more efficient than only onsite teaching.

"The participation of students in online teaching is lower compared to onsite teaching. Some good students were participating well. There was no change within this group."

(Government school teacher, Interview # EI-01)

"The interaction with students in online classes was difficult. There is no participation in class. The teacher cannot force students to turn on the camera. Some of them always turned off the camera. The teacher won't know what they are doing while joining a class."

(Government school teacher, Interview # EI-07)

66% of the students confirmed that their teachers could be contacted individually during the pandemic. 42% stated that their teachers were even available for individual (1 to 1) meetings if they had questions.

DISCUSSION

Based on the findings described in the previous section, the previously defined research questions can be answered sufficiently in the following way:

Table 3: Answers to research questions based on findings.

Research Question	Conclusion
Do Thai high school students have the required hardware and the needed IT skills to perform online learning sufficiently?	<ul style="list-style-type: none"> Thai high school students did in many cases not have the required hardware to perform online learning sufficiently. One-third of this group had no access to a computer or notebook. Even though the numbers for smartphone access were higher, experts confirm that online learning only using smartphones is inferior. In rural areas this is much more severe than in urban areas: Less than half of the students had access to a computer. A clear inequality in online education opportunities between urban and rural areas. The IT skills for online learning seem sufficient. Both students, as well as teachers, confirm this. Nevertheless, the broad unavailability of computers leads to lower skill levels for these IT devices.

Source: This study.

Taking these answers into account, the following section provides recommendations and an outlook.

Recommendations and Outlook

Following the findings the authors would like to provide two main recommendations, which are in line with feedback received from experts:

Recommendation 1: Implement actions to access computers:

To assure efficient online learning, computers are needed. As of today, a big group of students especially in rural areas has no access to computers. Government-supported projects should ensure that every student has access to a computer. Schools should explore opportunities to implement 'sharing communities' in which unused or slightly outdated IT equipment can be provided to students without access to IT devices.

"There should be programs making it possible for students and parents to get more affordable access to mobile devices with larger screens, e.g. tablets."

(Professor at the Faculty of Learning Sciences and Education, Interview # EI-05)

Recommendation 2: Adapt and provide teaching material

Reaching the students and motivating them to learn and to participate in the same way as they would do in onsite teaching requires an adaptation of the teaching material. Specific material for online teaching should be developed, promoted, and introduced to teachers.

“Online teaching should be made more interesting and more attractive for students. Teaching material including media should be provided, which is better adapted to online teaching. More pictures, audio, and videos. More activities are needed.”

(Government school teacher, Interview # EI-01)

The COVID-19 pandemic has not yet ended (Buot and Fama, 2022). Future pandemics are possible. In any case, the access for students to IT equipment and the improvement of IT skills are of high importance for their future. The existing IT inequalities in education for Thai high school students should be explored and monitored further to better understand the phenomena, localize trends, and develop solutions.

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Disney plus Hotstar on Twitter: Using netnography and word clouds to gain consumer insights

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ABSTRACT

Microblogging platform Twitter is being used more and more by businesses to promote and connect with their brands. The main goal of this manuscript is to identify the content typologies that Disney Plus Hotstar utilizes on Twitter to encourage customer engagement. This has been accomplished through the usage of technique termed as Netnography. The document then uses wordclouds to extract user data from the Disney Plus Hotstar twitter feed.

Keywords: Netnography, Twitter, Consumer Insights, Consumer engagement, and social media marketing.

INTRODUCTION

Marketers have taken cognizance as social media has become more mainstream. (Smith, Fischer, & Yongjian, 2012) Companies are using social media to address customer service situations, extract innovative ideas, and 'authentically' communicate with customers, (Williamson, 2010) in addition to digital advertising and marketing. The varieties of social media, which include mediums such as blogs, social networking sites, (Tong, Heide, Langwell, & Walther, 2008) and content communities, are extremely diverse. Social media allows businesses to engage with customers through broader media and a wider reach. Because of the immersive nature of these digital media, not only can companies communicate and share information with the customers, (Kaplan & Haenlein, 2010) but the customers can also interact and engage with the company and with each other. Organizations can utilize social media to develop relationships (Sashi, 2012) with current and potential customers, as well as create communities that collaborate to resolve issues. In social exchanges, these encounters alter the traditional roles of both the vendor and the buyer. In peer-to-peer interactions, buyers can provide value by creating content (Thackeray, Neiger, Hanson, & McKenzie, 2008) and even become impassioned advocates for the seller's products, influencing purchasing decisions of others. Opinions posted on social media play a significant role in shaping public opinion's behavior in a variety of sectors, (Mostafa, 2013) including purchasing items, capturing the "pulse" of stock markets, and voting for president, among others. An opinion can be defined as a statement which the person expressing it asserts a bold statement (Bai, Predicting consumer sentiments from online text, 2011; Eirinaki, Pisal, & Singh, 2012; Zhang, Zhang, Li, Wang, & Zuo, 2009) about a topic with a particular attitude. Web generated opinions in blogs and social networks have benefitted customer relationship management, (Wong, Xia, Xu, Wu, & Li, 2008) public sentiment tracking, and text filtering.

With the growth of the media sector, which includes social media, the entertainment industry has thrived over time, with the covid period providing a boost. The entertainment industry is no longer limited to theatres and television; instead, OTT platforms have come a long way and have a lot of promise. Because one of the most simple and engaging services supplied by technology is online streaming services media services, the lives of today's millennials are inextricably linked to technology. Every ardent viewer who likes streaming services for activity and entertainment has a better experience now that streaming services function on the internet and can be accessible on a variety of devices (Smart TVs, Computers, tablets, and smartphones) and at anytime from anywhere (Martins & Riyanto, 2020) just with the help of an internet connection. Netflix, Amazon Prime Video, Disney Plus Hotstar, Voot, ZEE5, Alt Balaji, Sony Liv and others are some of the most popular OTT platforms. Every streaming platform has its own loyal audience, (Laghate, 2019) but Disney plus Hotstar retains the most subscribed position in India.

Novi Digital Entertainment, a subsidiary of Disney 'Star India', owns Disney plus Hotstar, an Indian over-the-top streaming service. It offers two paid subscription plans: "VIP" which concentrates on domestic programs and sports material (including IPL cricket), and "Premium" which offers premium foreign films and television programs. Because of its low prices and diverse content, Disney plus Hotstar is one of India's top 10 OTT services. The plans are ₹ 499 for mobile, ₹ 899 for super, and ₹ 1499 for premium. (Network, 2022) They all have a one-year validity period, but the perks are varied. The popularity of Disney plus Hotstar is attributed to its low price, which is combined with a large number of local content. The audience is familiar with the word "Disney", therefore it is no surprise that Disney content is in high demand by both young and elderly. However, Disney plus Hotstar took a different approach in terms of strategy. Where Netflix restricts access to its content to

paying subscribers, (Putri) Disney Plus Hotstar offers a free version, an advertisement free version, and a version that locks some of its content while unlocking premium alternatives.

This study assesses Disney Plus Hotstar's Twitter presence and aims to examine how the platform has been able to capitalise on the appeal of social media. Using Netnography and word clouds, the authors seek to uncover the content typologies utilised by Disney Plus Hotstar on Twitter to enhance Consumer engagement and glean customer insights from Disney Plus Hotstar's Twitter presence.

REVIEW OF LITERATURE

Twitter

Twitter was launched in 2006 as a microblogging platform. It allows users to post (tweet), (Smith, Fischer, & Yongjian, 2012) respond to, and forward messages that are no longer than 140 characters long. This maximum of 140 characters has now been increased to 280 characters. Postings, which may include links to new stories, blogs, photos, and other content, (Boyd, Golder, & Lotan, 2010) appear in the stream of individuals who are following the content posted; most posts are also publicly accessible. Tweets can be sent directly to followers via instant messaging, (Jansen, Zhang, Sobel, & Chowdury, 2009) SMS, RSS, email, or other social networking platforms like Twittrific or Facebook, in addition to being displayed on a user's profile page. Other web services and applications are integrated within the twitter application. Twitter's user base has been developed as the largest microblogging site, attracting the attention of corporations and others interested in consumer behaviour, marketing and services. Because of its reliability, news organisations are increasingly using Twitter to receive reports during catastrophes and natural disasters. Several companies and organisations use Twitter or comparable microblogging services to communicate with their stakeholders. Twitter research has looked into a variety of topics, including social norms and behaviours (Boyd, Golder, & Lotan, 2010), self- presentation (Marwick & Boyd, 2011) and what and why users post (Jansen, Zhang, Sobel, & Chowdury, 2009; Java, Song, Finin, & Tseng, 2007; Naaman, Boase, & Lai, 2010). Information, news, views, complaints, and insights about daily activities are frequently requested or shared in tweets is particularly pertinent to this area. It was discovered that while 19 percent of tweets are brand related, the brand is not the major focus of nearly half of those posts. Users express thoughts about the brand and seek or share information about it in tweets where brands are prominent.

Social Media Marketing

Social media is a group of online services that allow people to search, share, evaluate, and co-create information made available via an (Chua & Banerjee, 2013) online information reservoir. It can alternatively be defined as a "collection of internet based applications that expand on Web 2.0S intellectual and technological origins and facilitate the development and exchange of content provided by users and marketers." users can construct and display their profiles inside a constrained system, as well as coherent lists of other users with whom they share connections, (Kaplan & Haenlein, 2010) using social networking services/sites (SNS). Users can use social networking sites to post comments, receive comments from others, join organisations and fan communities, organise events, (Nicole B. Ellison, 2007) use customised applications, and play games, among other things.

Online product and service marketing has evolved into one of the most important ways for businesses to engage with their target segment. These product and services include anything from search engine optimization and pay-per-click advertising (Matin, Khoshtaria, & Tutberidze, 2020) to pop-up ads and native advertising. Among these channels, social media marketing offers an excellent opportunity for businesses to develop a two-way channel of communication with their customers. This form of e-marketing can be used for a number of different communication strategies. It is possible to analyse the messages that businesses try to express to their target segment via social media (Dahnil, Marzuki, Langgat, & Fabeil, 2014). It has been shown that social media channels for businesses are often managed from the top down. However, the company's decision to pivot and react to market demands is based on employee and customer feedback received through various channels. There are various benefits of social media for businesses. Customer loyalty to a brand is known to rise when the brand is established on several social media platforms and upgrades its channels on a regular basis. (Erdogmus & Cicek, 2012) Another benefit observed is an increase in brand loyalty among consumers whose social media friends like and follow the brand. Predictably, social media's ability to offer a two-way channel of communication between businesses and customers played a key part in its rise. There are several advantages to using social media over other forms of marketing, such as the low cost of social media advertising, (Constantinides, 2014; Agmeka, Wathoni, & Santoso, 2019) the opportunity to use social media as a personal marketing and public relations tool at the same time, and the capacity to announce promotions. The adaptability gives businesses with a great tool for carrying out their marketing strategy. The important aspect of social marketing over traditional marketing methods is that it combines a variety of methods to target various areas of a marketing strategy. The capacity of businesses to construct a feedback loop on social media leads to better decision-making, (Tiago & Verissimo, 2014) more accurate quantification of strategy outcomes, increased productivity, and a more user-friendly environment for customers to voice their opinions. Furthermore, businesses frequently use social media to expand their market share and launch new ventures. The importance of social media in generating value and building relationship equity for premium businesses cannot be overstated. Brands with medium to high degrees of involvement, and thus brand equity and loyalty, take centre stage in purchase intention for this sort of consumer. As a result, the significance of social media in today's marketing climate cannot be overrated. Companies are attempting to engage with their customers through new channels and to broaden their reach on the internet. Firms strive to increase their market visibility and build brand awareness and loyalty. Despite the fact that practically

all established companies and start-ups use social media, their main actions on these platforms are focused on attracting more attention to their medium to high level engagement products while competing on pricing and creating relationships with consumers.

Consumer Engagement

Consumer Engagement, in theory, is a component of relationship marketing (Vivek, Beatty, & Morgan, 2012) that fosters consumer connection and contact. It is a mental state that happens when a focus equals object engages with the customer and co-creates the customer experience. The key point of consumer engagement changes (Brodie, Hollebeek, Juric, & Ilic, 2011) with the circumstances. It could be a person, a community, a company, a product, a brand, or any other marketing activity with the ability to influence consumer experience. Interaction and participation are required for consumer engagement. While engagement without contact may not result in the desired consumer experience, (Verma, 2014) active involvement and participation help to co-create outstanding customer experiences.

Consumer involvement is a difficult notion to describe, conceive and operationalise, and researchers and marketers needed to do more to define, conceptualise, (Barger, Peltier, & Schultz, 2016) and operationalize it. Brand loyalty, relationship marketing, Concentric marketing, marketing orientation, customer relationship marketing, and social networks are all relational notions that can be used to analyse consumer interaction. Because of social media's interactive and collaborative nature, (Barger & Labrecque, 2013) antecedents and effects of brand engagement can be examined using important social media usage metrics such as expressions of approval, reviews, comments, and shares. Increased consumer satisfaction, (Cummins, Peltier, Schibrowsky, & Nill, 2014) trust, absorption, client retention, share-of-wallet, and profitability are all possible relationship effects of engaged social media usage.

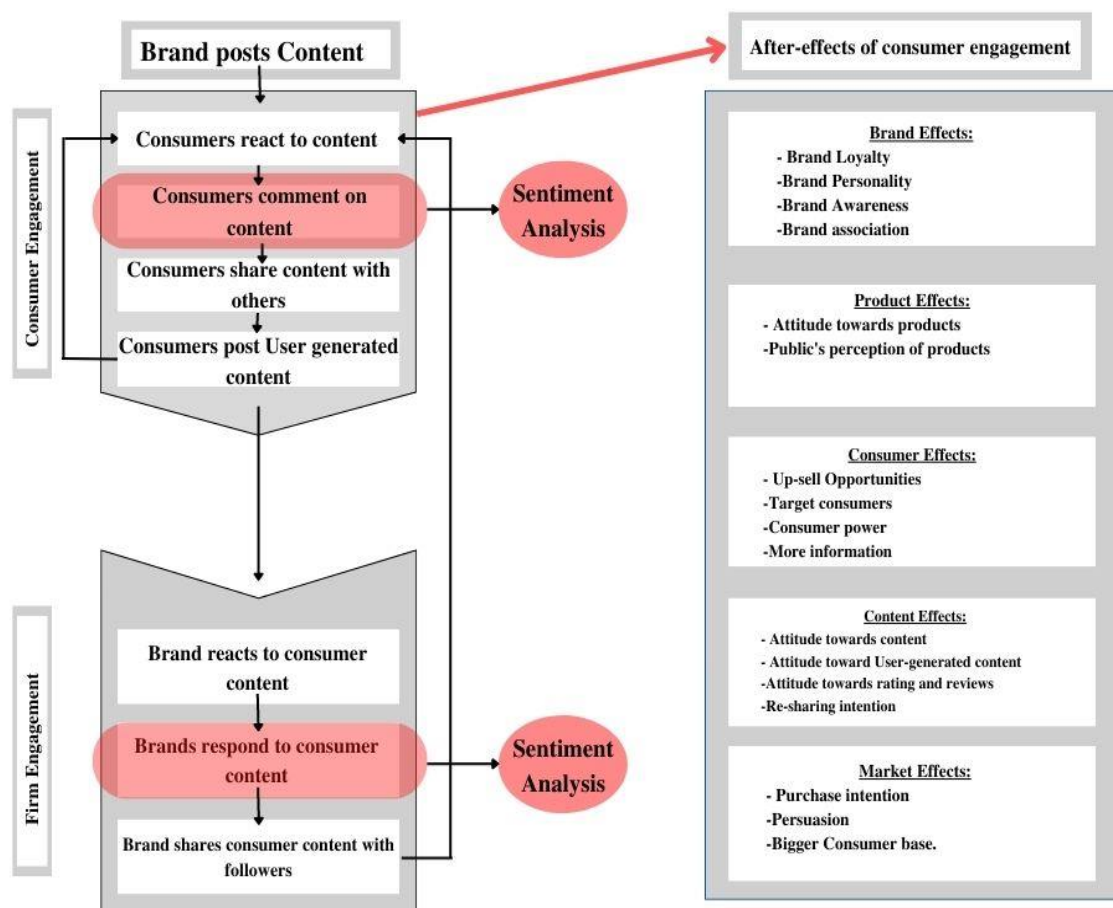


Fig 1: Effects of consumer engagement and its relation with firm engagement.

A conceptual model has been created to help frame the research. It depicts how consumer engagement occurs and leads to firm engagement, as well as the effects of consumer engagement on brand, products, consumer, content, and market. As indicated in the framework, consumers respond to content, comment on postings, share content with others and lastly if they are highly satisfied and/or passionate about the content/ products or services, they add user generated content. The sentiment analysis in consumer engagement can be done at the stage where consumer comments on the content. Furthermore, when a consumer created user-generated content, the brand reacts to it, then responds to the consumer (at which point sentiment analysis can be

performed) and finally, the brand shares the consumer's content with their followers. This cycle now continues by the consumers' interaction with the brand's content. The framework also includes the following descriptions of the after-effects or implications of consumer engagement. The first is the brand effects, which explain that when a consumer engages with a brand's content and feels a sense of belonging, it can improve brand loyalty, awareness, personality, and association. The second one is the product effects, which describe how a consumer's attitude and perception of products evolves when he/she engages (usually in a positive manner). Next, there are consumer effects, which shows that when a consumer engages with a brand and becomes a client, upselling opportunities increases. It is also easier to identify target consumers and present them with more information about the products/services. Next comes the content effects, where the brand has the power to examine the attitudes of consumers and potential consumers regarding the information that they have published. Firms can also try to study the attitude of the consumers towards their brand by analysing the re-sharing intention when consumers engage with the brand's content by creating user generated content and giving rating and reviews. The final one is market effects, which assist consumers in making decisions about acquiring products/ services. When a consumer interacts with a brand's content, he/she gains more knowledge and information about the company and is better able to make an informed decision. Consumer engagement also allows firms to reach out to a new audience, resulting in a larger consumer base.

People are increasingly viewing social media applications as integral parts of their daily lives, and they are more prone to shift their interactions to virtual platforms for instance: (Dwivedi, Kapoor, & Chen, 2015; Rathore, Ilasvarasan, & Dwivedi, 2016; Taylor, Lewin, & Strutton, 2011; Zhu & Chen, 2015) Facebook, Twitter, Instagram, LinkedIn etc. this has a favourable impact on their attitudes and behaviours regarding various forms of social media technologies. Consumer interaction has increased in tandem with the growth of social media. It is now much easier to study and investigate how consumers interact with the content that businesses put on their social media pages. As a result, (Algharabat, Alalwan, Rana, & Dwivedi, 2017; Abed, Dwivedi, & Williams, 2015; Hawkins & Vel, 2013; Hinz, Skiera, Barrot, & Becker, 2011; Rathore, Ilasvarasan, & Dwivedi, 2016; Zhu & Chen, 2015) social media applications have been identified as one of the most effective and influential implications that has gradually been integrated into most facets of people's lives including education, social, business, commercial, political.

Firms have been awaiting to use social media in many elements of their interactions with customers in many situations, (Alalwan, Rana, Dwivedi, & Algharabat, 2017; Zeng & Gerritsen, 2014) such as facilitating information discovery, interactivity, promotion, and enhancing customer buying behaviour. As a result, (Leefliang, Verhoef, Dahlstrom, & Freundt, 2014; Filo, Lock, & Karg, 2015; Schultz & Peltier, 2013) businesses have evolved a number of interactive techniques and procedures to improve their brand identification and marketing success.

RESEARCH METHODOLOGY

Netnography

The growth of the internet, together with the emergence of online communities and blogs has transformed the way consumers engage with one another during the previous two decades. (Branthwaite & Patterson, 2011; Füller, Jawecki, & Mühlbacher, 2007; Maulana & Eckhardt, 2007) User-generated data on consumers' desires, wishes, beliefs and experiences in regard to products, services and their social lives is practically seamless available within these online contexts, both expressly and implicitly. As a result, (Bartl, Kannan, & Stockinger, 2016) a systematic procedure for identifying, selecting and analysing massive volumes of online consumer interactions while wasting less time and money became necessary. This is where the term "Netnography" was coined.

In the late 1990s, marketing professor Robert Kozinets pioneered netnographic research. The term "Netnography" is a combination of the words "internet" and "ethnography". Netnography encompasses more than the use of classic ethnographic methodologies in an online setting to conduct qualitative research. On one side, typical ethnographic manual data gathering methods are augmented by computer-based data collection. Access to information is facilitated by the ability to download communication data directly from an online community. (Kozinets, 2002; Piller, Ihl, & Vossen, 2011) It is a humanistic method of immersing oneself in the consumer domain and gaining a comprehensive understanding of human behaviour. Netnography enables for the extraction of unbiased consumer information by listening in on organically occurring consumer discussion in online forums. Visual data, such as video, audio, visual and graphical data has also been added to the study.

Sentiment Analysis

Opinions have a crucial role in practically all human activities since they shape our actions. We seek out the opinions of others whenever we need to make a decision. Businesses and organisations in the real world are continuously looking for consumer or public feedback on their products and services. (Liu, 2012) Individual customers also want to know what other people think about a product before buying it, and what other people think about the political candidates before voting in a political election. When a person wanted an advice in the past, he or she turned to friends and family. (Bai, 2011; Eirinaki, Pital, & Singh, 2012) When a company or organisation desired public or consumer feedback, they conducted surveys, pools and focus groups. For marketing, public relations, and political campaign companies, obtaining public and consumer opinions has long been a lucrative business. Individuals and organisations are increasingly leveraging the content in social media (e.g., reviews, forums, debates, blogs, microblogs, Twitter comments and postings on social networking sites) for decision-making.

Opinions published on social media have a significant impact in influencing public opinion's behaviour in areas as diverse as purchasing items, catching the stock market's pulse etc.. (Kim & Hovy, 2004) A statement in which the bearer of an opinion makes a particular assertion about a topic using a specific emotion can be considered an opinion. Web-generated sentiments in blogs and social networks have lately emerged as a viable resource for extracting user sentiments for customer relationship management, public opinion tracking, and text filtering. Because millions of opinions voiced on a single issue are highly unlikely to be prejudiced, knowledge gathered via social networks is tremendously valuable. Because of the emotive character of such opinions, they are easily understood by the majority of readers, and they are increasingly used as the foundation for marketing research, business intelligence, stock market prediction, and image monitoring choices. (Zhang, Zhang, Li, Wang, & Zuo, 2009) Sentiment analysis is now used to examine online opinions. Sentiment analysis is a study that has lately received a lot of attention. (Pang & Lee, 2004) (Pang, Lee, & Vaithyanathan, 2002) Because of the possible uses, a lot of work has gone into identifying polarities, the subjective character of text documents, and even full-fledged ratings. These strategies, for example, can be used to examine user input from a different perspective. Another use is to detect and eliminate flames. By incorporating such techniques into current search engines, users will be able to browse documents containing information specifically "for" or "against" a topic. According to research of Twitter activity, (Thelwall, Buckley, & Paltoglou, 2010) more than 80% of users either share information about their everyday experiences with their followers or update them on what they are really doing. Twitter was chosen to perform the analysis for this study because it's the largest, most well-known, and most popular microblog web site. The data comprised of 1000 tweets for the brand Disney Plus Hotstar. In accordance with (Thelwall, Buckley, Paltoglou, Cai, & Kappas, 2010), only English-language tweets were selected to avoid any potential difficulties that may occur when evaluating tweets in other languages.

ANALYSIS & FINDINGS

Content Analysis

According to research, (Ahuja & Medury, 2010) brand engagement content published by a company on social media can be divided into three types: organisational, promotional, and relational. The following Content typologies were derived from a netnographic research of the Disney Plus Hotstar Twitter feed.



Fig 2: Informational content posted by Disney plus Hotstar

Informational Content identifies how valuable and resourceful social media content is for consumers. (Chen, Clifford, & Wells, 2002) The relationship between the ability of an advertisement to provide information to viewers and its acceptance has been well established. (Dolan, Conduit, Fahy, & Goodman, 2015) Furthermore, obtaining various types of information has been identified as the most important reason consumers use the internet, and degrees of information and attitudes towards the website have been shown to be positively associated. Some of the examples are posting images of the show's cast and announcing the show's premiere date, providing information on new hashtags to use for forthcoming challenges with new content, combining national news with relevant content and many more.

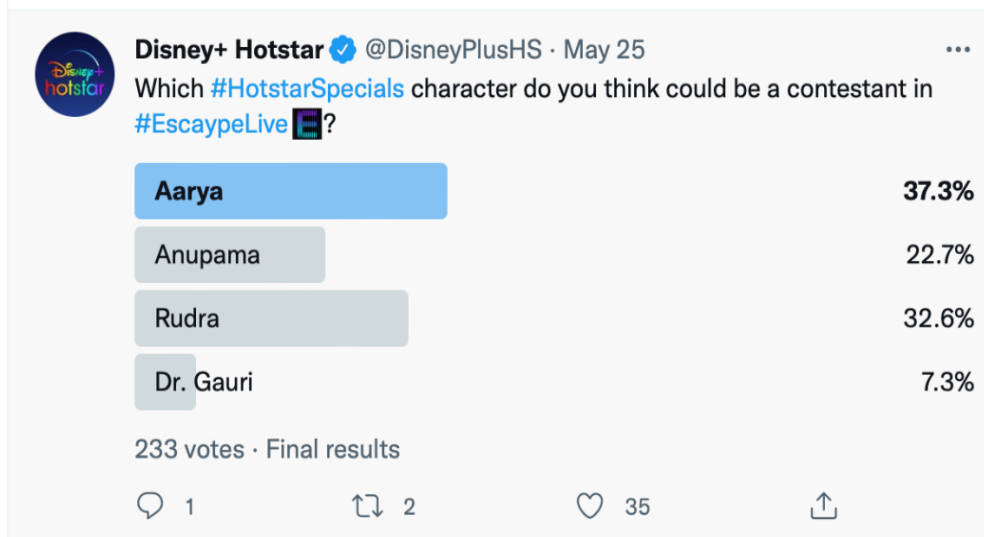


Fig 3: Relational content posted by Disney plus Hotstar

Relational Content is described as the content that is shared on topics that are important to consumers and that shows the organisation's sensitive side. The goal is to establish a rapport with the clientele. Some of the examples are celebrating festivals with new content, specials for parents day, friendship challenges with celebs from forthcoming shows/series/movies, motives for watching new content etc.



Fig 4: Promotional Content posted by Disney plus Hotstar

Promotional Content is described as information shared on product features, pricing, new items, product comparisons, promotional efforts, and responses to any product-related complaints. Posts that passively persuade people to buy the product are also featured. Some of the examples are information about new TV show/movie, promoting content by collaborating with influencers, sharing memes about new content for improved consumer involvement, posting little spoilers for new series etc.

Sentiment Analysis

Sentiment analysis was conducted for 1000 tweets posted by Disney Plus Hotstar's current and potential subscribers. The data from Twitter was extracted using the tool "Scrape Hero Cloud" and the sentiment analysis was conducted by using the tool "Monkey Learn". Table shows a sample of tweets for Disney Plus Hotstar and the sentiment evaluation done by the tool.

Table 1: Sample of tweets posted by Disney plus Hotstar with sentiment evaluation

S no.	Tweets	Sentiment Evaluation
1.	@DisneyPlusHS Enjoyed it a lot!! The trio was awesome and #DrashtiDhami being first time there, how she's welcomed and her replies, loved everything!!	Positive
2.	@DisneyPlusHS can we have the BFG movie on #DisneyPlusHS	Neutral
3.	@DisneyPlusHS Hey, am not able to watch the movie every 30 sec the movie freezes. It's so irritating. Please fix it.	Negative
4.	@DisneyPlusHS IMAX enhanced still not there?? And what is this poor streaming quality on mobile and laptops? Where is 4K Ultra HD?	Negative
5.	@DisneyPlusHS Not able to play anything.	Negative
6.	@DisneyPlusHS Why haven't you televised the F1 testing in Bahrain happening this week! Indian F1 fans will be pretty unhappy with this!	Negative
7.	@DisneyPlusHS Awesome concept escaype live web series, good message for all mobile users.	Positive
8.	@DisneyPlusHS that's a great initiative by Disney plus Hotstar team...well done!!	Positive
9.	@DisneyPlusHS Thank you Disney for giving me my 5 days dose.	Positive
10.	@DisneyPlusHS will there be a second season for OK Computer?	Neutral
11.	@disneyplusHS Can't wait to see her acting skills blow people way.	Positive
12.	@DisneyPlusHS is not working since morning!	Negative

The tool "Monkey Learn" analyses the tweets for polarity and divides them into three categories: positive, negative and neutral. The three possible sides of a given tweet are depicted in the figure as follows: red for the negative side, yellow for the positive side, and the merging of both the sides for the neutral side. The sentiment of a tweet can lie anywhere within this spectrum.

POLARITY EVALUATION

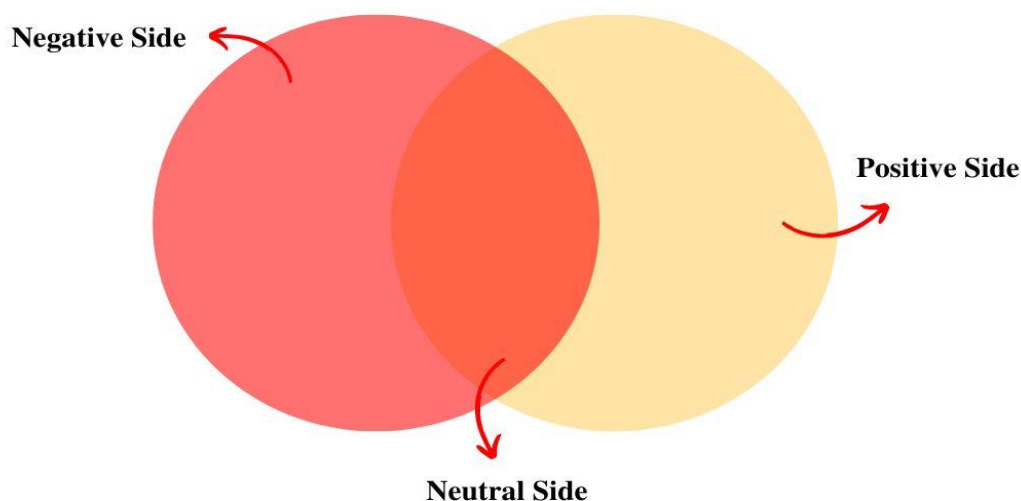


Fig 5: Polarity Evaluation

Furthermore, figure displays sentiment by percent and sentiment by count to understand how many tweets fell onto the good, negative and neutral category respectively out of the total 1000 tweets.

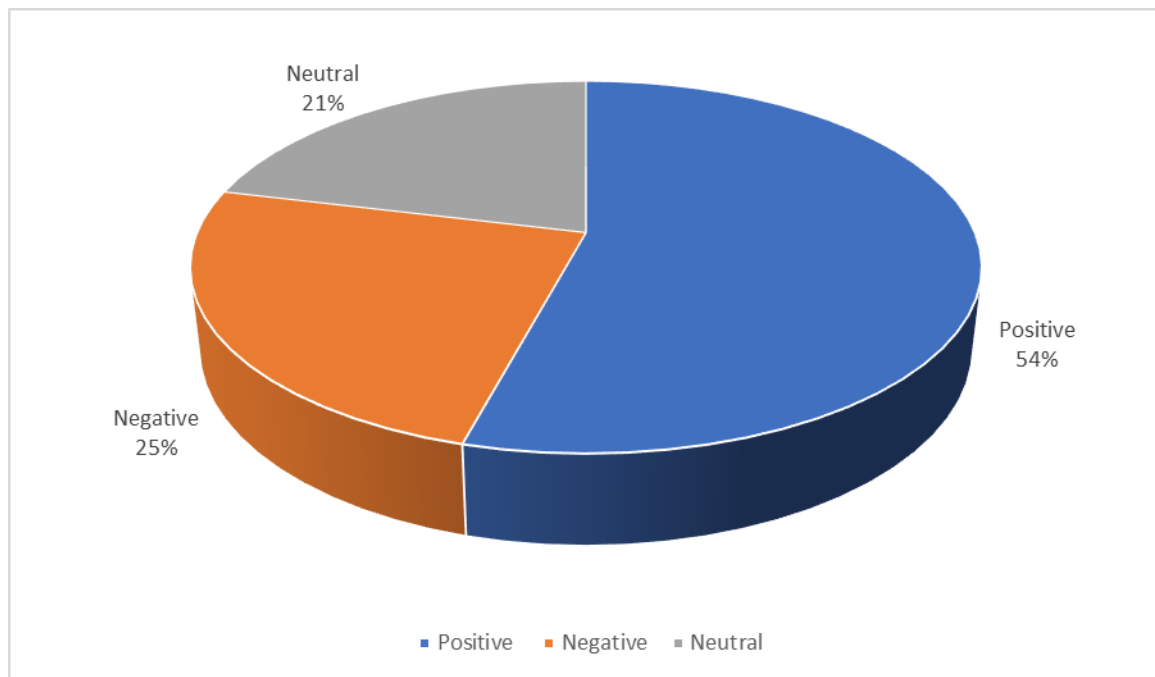


Fig 6: Polarity by percentage

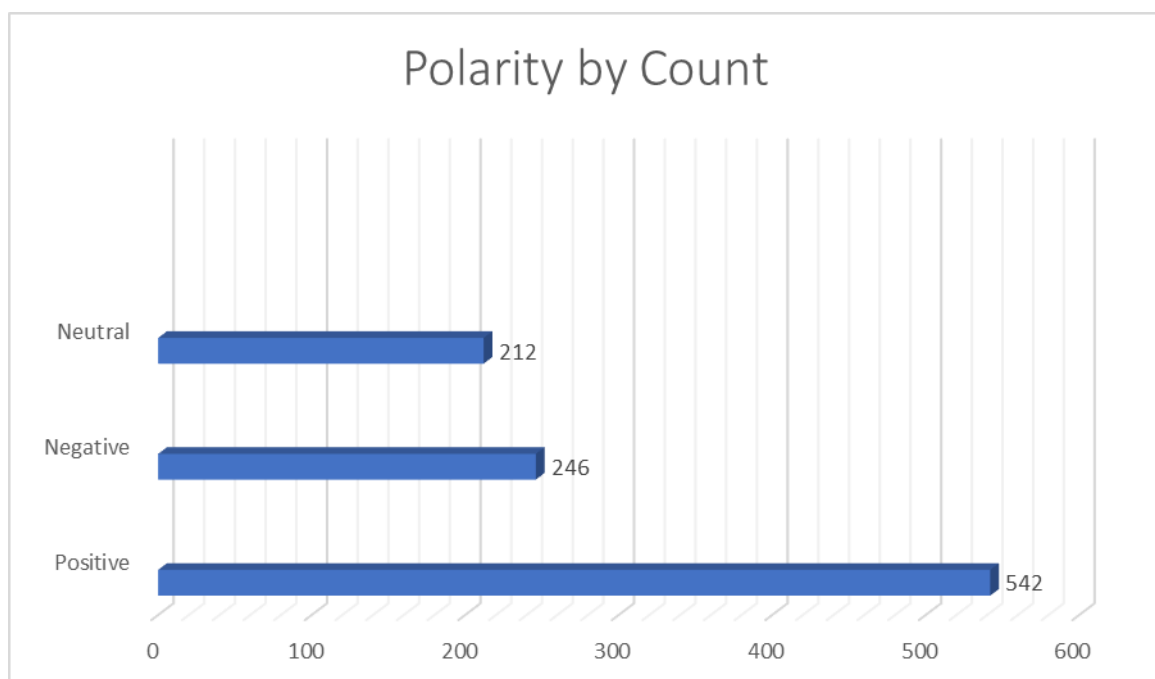


Fig 7: Polarity by count

There were a total of 212 neutral tweets, 246 negative tweets, and 542 positive tweets, as depicted in the figure.

Despite the fact that SA has been the subject of several research, none of them have simply examined consumer sentiments of the prominent global OTT platform Disney Plus Hotstar. This gap is addressed in this study. By examining brand polarity, the study deepens our understanding of text mining. Finally, the study adds to the body of knowledge in this under-represented field by focusing entirely on online texts rather than conventional off-line data.

Generation of Word clouds

Using the Disney plus Hotstar Twitter handle, a word cloud was created, revealing the word cloud shown in the figure below with the help of the tool "wordclouds.com". A really remarkable occurrence was illustrated by this word cloud, which was constructed from 1000 tweets. The term "Disneyplushs" was found to have a frequency of 994, followed by "ipl", "live", "hotstar", and "alwaysramcharan". Consumers have been closely involved as Disney plus Hotstar engages in online interactions with them. This is evidenced by (i) Disney plus Hotstar's enormous Twitter following (5,33,500) and (ii) the semantics disclosed in the consumer base's chats. The brand has multiple postings centred on innovative and relatable material

that it is striving to achieve across various sectors such as sports, TV shows, movies, short films, and so on. Given Disney Plus’s appeal to people of all ages, the platform’s parental restrictions are rather strict; there is a Kids-Safe mode to ensure age-appropriate material. On the app, there’s also a section dedicated to Disney plus content that curates and organises titles from Disney, National geographic, Marvel, Star Wars, Pixar for simple navigation.

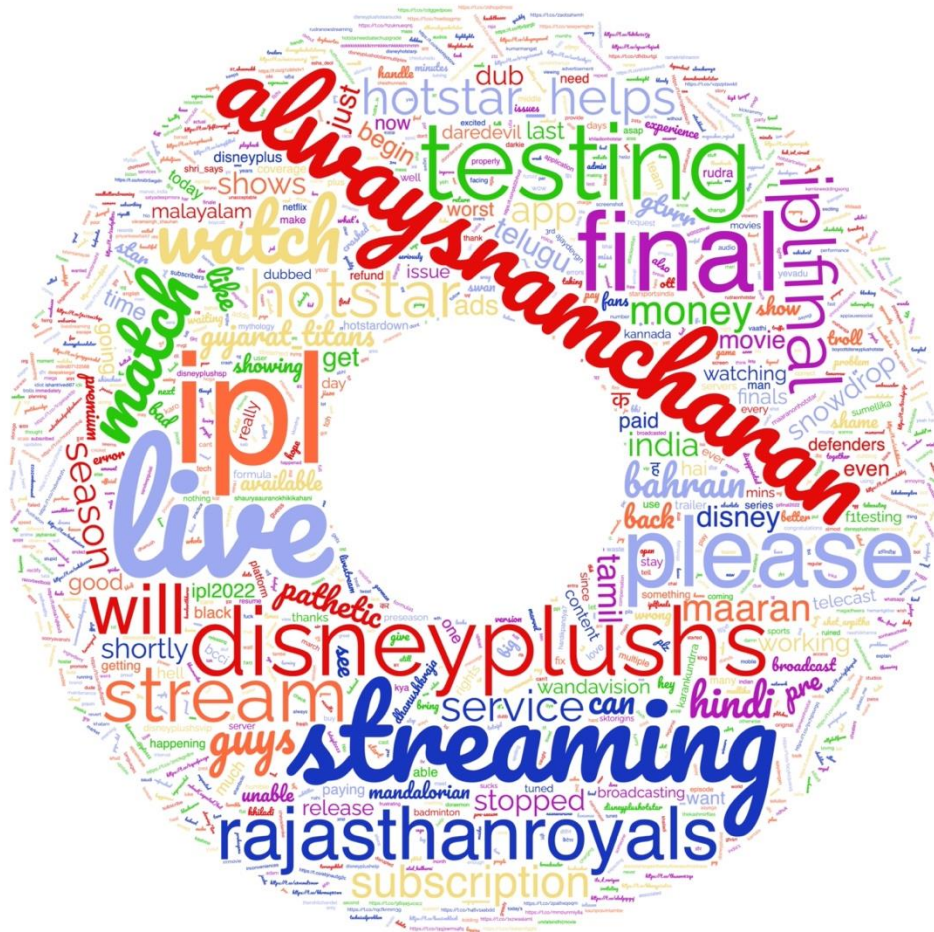


Fig 8: Twitter word cloud for Disney Plus Hotstar

Disney Plus Hotstar has been effective in generating good content as well as eliciting consumer responses to the content that they are providing to their consumers. When consumers believe a brand to be successful, it is considered successful. By encouraging consumers to create a textual conversation around the terms ”disneyplushs”, ”ipl”, ”alwaysramcharan” and so on, Disney plus Hotstar has been able to demonstrate its effectiveness in achieving its consumer engagement objectives by catering to many areas of content such as sports, trending TV series, original TV shows, and unique content across several languages. The brand was also successful in attracting consumers to content to their liking and making them loyal towards actors. The word cloud demonstrates Disney and Hotstar’s accomplishment in establishing Twitter as a successful brand point of interaction that not only generates a sufficient level of consumer engagement but also the proper consumer emotion towards the brand.

CONCLUSION

Disney Plus Hotstar has successfully used Twitter for consumer engagement with over 3000 interactions in terms of responding to consumer inquiries, solving their problems, and making a connection with their users. Disney Plus Hotstar is able to leverage a variety of content typologies to establish an emotional connection with its subscribers, which is consistent with the uses and gratifications hypothesis. Additionally, a qualitative study demonstrates that the business has been effective in hosting a range of material, with informational, promotional, and relational content being able to provide a sizable amount of consumer engagement. The word cloud also demonstrates how well Twitter is used to engage with consumers. Users have posted a sizable number of thank you messages and there have been a lot of retweets, which demonstrate this. While the users were sharing content posted by Disney Plus Hotstar on Twitter, the business was also sharing content shared by delighted users.

MANAGERIAL IMPLICATIONS AND FUTURE RESEARCH DIRECTIONS

A number of software solutions that are assisting businesses in analysing the large amounts of data are now available in the sector of digital marketing. These tools aid businesses with competitive benchmarking and analytics. Companies need to have clearly defined plans in place for controlling their online presence at a time when online reputations have a significant influence on brands. Companies should have systems in place to spread favourable consumer feedback throughout their online

social networks, but they should also have suitable channels for customer complaints. Similar to this, businesses should be prepared to provide important information that will benefit consumers in terms of their organisations, promotions, or personal relationships and foster a culture of engagement.

Consumer's involvement in the marketing process can increase its efficacy, and this concept has been understood for a long time now. Gaining a product's practical value is insufficient for the millennial demographic of people who were born in the digital era. They are looking more and more for the emotional high that comes from engaging with a brand in novel ways. Marketer now a days must comprehend how the newest digital technologies may provide their clients more value by giving them a sense of participation in an experience shared by their peers virtually.

While sentiment analysis is used in this study to categorise customer sentiments in an impartial manner, the underlying causes of these opinions are not revealed by this analysis. To identify the most representative reasons mentioned behind each sentiment, future research employing sentiment topic recognition (STR) should be carried out. It should be feasible to learn more about the fundamental factors influencing positive or negative feelings as a result of this investigation. Furthermore, while this study only looked at how social media marketing affected consumer engagement, which in turn affected consumer satisfaction, future studies can be conducted on how other elements such as pricing, trust, and e-WOM might affect consumer purchase intentions and satisfaction. In order to use the findings as comparative material, more research might be done on the companies or brands in similar industries.

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Exploration of the consideration factors of pure e-commerce business for transforming into new retail model

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ABSTRACT

Since the outbreak of COVID-19 in the early year 2020, many businesses and industries have encountered serious impact on their operation and maintenance, but the significant growth rate of e-Commerce industries has caught all people's eyes. Many domestic and foreign leading businesses are forced to speed up their configuration for moving into e-Commerce and m-Commerce. For e-Commerce businesses, they do not have much physical communication and interaction with consumers, it may eliminate the expensive management costs, but they cannot provide customers with good opportunities for experiencing. So, how to pure e-Commerce transform into the New Retail Omnichannel operating model is an important research issue. In view of all, this study intends to apply Analytic Hierarchy Process (AHP) in combination with the Fuzzy Theory to analyze a decision-making issue, namely, what factors are deemed important or concerns to "the pure e-Commerce businesses" in their future transformation into New Retail Omnichannel operating model. In the results of this study, "increase revenue", "develop customer's potential market", "increase stock turnover", "reduce reverse logistics costs", and "increased management costs" are the five consideration factors most important to transformation into new retail model. The results from this study provide the pure e-Commerce businesses with considerably useful reference in the issue of transformation into New Retail operating model in their future.

Keywords: e-Commerce, New Retail, Omnichannel, Analytic Hierarchy Process, Fuzzy Theory.

INTRODUCTION

Since the worldwide outbreak of COVID-19 in the early year 2020, a large number of different businesses and industries have encountered serious impact on their operation and maintenance (Wang et al., 2020). However, there are also some types of industries that make responses to the changed consumption behavior of consumers to grow successfully in the tough times. Among others, the significant growth rate of e-commerce and particularly cross border e-commerce industries has caught all people's eyes (Bhatti et al., 2020; Guthrie et al., 2021). In view that the fast change in industries resulted from the pandemic virus has become an inevitable trend, many domestic and foreign leading businesses in traditional retail business, such as Walmart, Costco and Carrefour, are forced to speed up their configuration for moving into e-Commerce and m-Commerce (mobile commerce) because more and more consumers change from offline shopping to online shopping.

On the other hand, most of the pure e-Commerce platforms do not have a physical location for business operation. Almost all business-related activities of e-Commerce from product exhibition and procedures of transaction and payment to pre-sales and after-sales services are done online and the e-Commerce operators completely need not be in real contact with customers. This largely eliminates the expensive store rent, utility costs, personnel costs and management costs (Gajewska et al., 2019). However, compare to physical retailers, the pure e-Commerce businesses are in a congenital inferior position in terms of their operation, that is, they do not have much physical communication and interaction with consumers, nor do they provide customers with good opportunities for experiencing products, consultations and after-sales service (Jusoh & Ling, 2012). Further, for pure e-commerce businesses, the delivery of products ordered by customers is completely relied on a logistics network established by cooperating with third party logistics companies. In the case there are orders come from suburban areas that are located faraway or not supported by currently applicable logistics systems, a budget for investing more costs must be planned to ensure cooperation with a third party logistics company that provides a more comprehensive logistics network. This will doubtlessly increase the operation expense and lead to failure in accurate control of logistics delivery information and the security of products in delivery (Fan et al., 2020). For customers who go shopping on e-Commerce platforms, instant delivery of ordered products and fast return and exchange of purchased products would have direct influence on their intention of repeat consumption (Couture et al., 2021; Meng, 2021).

Further, from the consumers' point of view, the current consumption environment and scenes provide them with two types of consumption models at the same time, i.e. they can go shopping in offline physical retail stores or on online e-Commerce platforms. As a result, consumers nowadays sprout a new thinking model of consumption before they purchase. That is, many consumers would get an idea of the general specifications and price ranges of the target products online before they inquire and buy the products directly in the physical stores. There are also other consumers who will first go to the offline physical stores for a direct contact of the real products, and select to compare prices on e-Commerce platforms and place their orders online.

The above-mentioned two consumption models respectively have their pros and cons; however, they bring different problems to the online pure e-Commerce businesses. While the online pure e-Commerce businesses need not pay high costs for store operation, maintenance and personnel management, they have no real contact with customers and could not provide products for customer experiencing or provide other better services to customers. Generally, customers do not have a great affection for e-Commerce brands and accordingly, have relatively low stickiness to them. Another problem with e-Commerce is the endless consumption disputes caused by online shopping. For instance, a consumer placed an order online and hopefully anticipates the receipt of adored product purchased online, but eventually finds the received product quality is not as good as expectation or the received product is different from what is expected. In this case, if the e-Commerce business did not establish good customer risk management and after-sales service system to handle the customer's complaint, it is natural the buyer would no longer trust the e-Commerce brand (El Haq et al., 2021).

In view of the above facts, the pure e-Commerce businesses need to find a way to get a balance between controlling cost and providing consumer experience, in order to provide consumers with the best possible services as well as product prices that mostly satisfy consumers' marginal benefit. By doing these, it would increase the existing and the potential customers' intention to purchase and largely influence the customers' satisfaction with the products and even the brands (Wang & Ng, 2020). Therefore, there are more and more domestic and foreign pure e-Commerce businesses pay great attention to the development trend of the new sales channel model of integrating online purchase with offline physical stores. For example, Alibaba, the largest e-Commerce business entity in China, had established a physical store, namely, Fresh Hema, in 2015 to sell fresh foods. This is the first time the concept "retail stores are also logistics sites, and on-shelf products in the store are also storages" is introduced into the market, which unites the online and offline stocks (Kim et al., 2019). Another example is Whole Foods Market, which is an American physical retail company acquired by the leading e-Commerce company Amazon in 2017. Whole Foods Market has its own powerful logistics system and emphasizes that all products, no matter they are ordered online or offline, will be delivered within two hours to thereby create a brand differentiation from other companies in the same sector¹. Meanwhile, Shopee, a big-scaled Singaporean consumer-to-consumer (C2C) e-Commerce Company, who established a number of physical stores in Taiwan from August to November, 2021 to provide the so-called "Shopee store to store" service.² With the establishment of physical stores, products can be more smoothly delivered to largely reduce the logistics cost; and it is possible for customers who come to the physical stores for sending or picking up packages to repeat consuming in the stores. In this way, the physical stores can provide customers with faster and exact services³.

From the above brief overview of the active development and integration of physical stores with existing e-Commerce business by some prominent e-Commerce companies, either Online to Offline (O2O) or Offline to Online (O2O), it can be seen the "new retail" era of omnichannel sales model emphasizing Online merge Offline or Offline merge Online (OMO) has come. New retail is actually not a new operation tool or platform, but an innovative business thinking (Yang & Zhang, 2017). A biggest difference between New Retail and Pure e-Commerce is that New Retail emphasizes the business strategy of O2O, i.e. providing consumers with a consumption model across online and offline for consumers to experience services and products more smoothly. In New Retail, data of multiple online and offline sales channels are integrated or merged and a membership system can be established, so as to implement more precise consumer-directed marketing strategy to reduce the business budget for marketing. In conclusion, New Retail is a data-driven pan-retail style centered on consumer experience; it deems consumer's requirement, experience and perception as its core concept of business operation and emphasizes the OMO sales model to integrate retailer industry, e-Commerce industry, warehousing and logistics industries, and even manufacturing industry with one another. To realize this foreseeing and visioning target, online pure e-Commerce businesses must go to offline to develop their physical channels to fulfill the core spirit emphasized by New Retail, i.e. becoming omnichannel.

From the above described background and motivation discussion, it can be found the e-Commerce industry itself is a quickly developing and ever changing and growing market. Presently, there are numerous middle- and small-scaled enterprises that engage in pure e-Commerce businesses in Taiwan. However, these businesses do not have any physical sales channel, it is absolutely not easy for them to transform into the New Retail Omnichannel operating model. In addition to the already oversaturated retail market, they are also facing numerous strict challenges, such as how to definitely find their own market niche in the future New Retail market, how to use their pre-existing capitals properly to master the existing and the potential customers' requirements, how to provide even better product experience and sales services to the consumers, and how to build their own channel brands to expand their new retail omnichannel businesses in the future.

In view of the above discussion, this study intends to apply Analytic Hierarchy Process (AHP) in combination with the Fuzzy Theory to analyze a decision-making issue, namely, what factors are deemed important or concerns to "the pure e-Commerce businesses" in their future transformation into New Retail Omnichannel operating model. It is hopefully the analytic results could provide some substantive references and suggestions to the existing or future e-Commerce businesses.

¹ KKnews.cc, <https://kknews.cc/zh-tw/food/mr425a2.html>, 2022.

² Shopee, <https://shopee.tw/m/spxservicepoint#T1>, 2022.

³ INSIDE, <https://www.inside.com.tw/article/24769-shopee-physical-store>, 2022.

LITERATURE REVIEW

New retail

In 2017, when the sales channels constantly increase, Jack Ma, who is the Chairman of Alibaba at that time, raised the concept of New Retail. According to Jack Ma, the pure e-Commerce has died, and both e-Commerce businesses and traditional retailers must turn to the OMO Omnichannel New retail. This concept brings all enterprises engaged in e-Commerce and physical retail to think about future transformation into the new business operating model that integrates all online and offline sales channels (Wang & Ng, 2020). More specifically, the New retail is an Omnichannel business operating model that converges online and offline, emphasizes consumer-focused, and is driven by technical means, such as big data and artificial intelligence (AI). When the products, logistics and customer services available on all online and offline channels, including cloud platforms, online shopping platforms and physical stores, are fully integrated with digital data, all participants on the value chain can share the data, and customers can have more complete product and service experience. In this way, it is able to rebuild the critical factors in retail activities, namely, people, things and places. More specifically, the New retail has three features, namely, omnichannel, online merge offline (OMO) and customer experience (Verhoef et al., 2015; Liu et al., 2020; Lemon & Verhoef, 2016).

In the past ten and more years, there was actually quite a lot of literature in the academic research field that is related to the discussion of e-Commerce and retail. Most articles in the literature focused on the discussion of consumer attitude and behavior. For example, in the research conducted by Nisar and Prabhakar (2017), they discussed the influence of online service quality of e-retail industry on customer satisfaction, loyalty and consumption intention; in the research conducted by Wagner et al., (2020), they discussed the influence of mobile channels on traditional e-retail industry and indicated that consumer shopping experience can be effectively enhanced by creating a shopping APP. However, since New retail is an issue emerged only in recent years, there are few studies that discuss the new retail channel and operating model and its value to consumers.

Fuzzy Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) was developed by Saaty in 1977, which is one type of MCDM particularly for solving decision-making issues with multiple evaluation criteria and alternative solutions and has a wide range of applications (Saaty, 1980). Up to date, AHP has been widely applied in solving various decision-making issues involving ranking, selecting, evaluating, and predicting (Saaty & Vargas, 1982). AHP is advantageous in that it helps users to decompose the complicated decision-making issue into several independent sub-issues and to organize or simplify these sub-issues into an evaluation hierarchical framework (Shee et al., 2003). The evaluation hierarchical framework includes different evaluation elements for solving the decision-making issue, including evaluation dimensions, evaluation criteria or factors, and alternative solutions (Meade & Presley, 2002). From the evaluation hierarchical framework, the decision maker can clearly find out the relationship among different hierarchical levels to thereby determine the most appropriate evaluation elements and even the optimal solution for the decision-making issue (Nikou & Mezei, 2013).

It is true the conventional AHP enables comparison of the degree of importance of the evaluation elements. However, in the process of evaluating the decision-making issue, human thinking is usually characterized by a degree of fuzziness and there is not always a distinct boundary between the decision maker's judgments with respect to the pros and cons of different alternatives, which might lead to bias in the evaluation results (Chan & Kumar, 2007). Therefore, Van Laarhoven and Pedrcyz (1983) proposed a method that combines the Fuzzy Theory with AHP and is referred to as Fuzzy Analytic Hierarchy Process (FAHP) for overcoming the above-mentioned problems. In FAHP, much more strict and complicated computing is applied, so that the experts' judgment and answer to the degree of importance of any two elements in the evaluation hierarchical framework compared in pairs can more actually reflect the situation in which humans think about something, while the disadvantages, such as being fuzzy or overly subjective, accompanying with humans' judgment about the pros and cons of different evaluation elements and alternatives can be compensated. In this way, it is possible to reduce the production of incorrect analytic results and to more effectively find out the optimal solution for decision maker (Yang & Lin, 2019).

Different from AHP, the FAHP converts data into triangular fuzzy numbers, and the calculation is more complicated. Besides, the results are more reliable and closer to the actual situation. The steps of FAHP calculation are described below:

1. Establish the hierarchy structure of evaluation: After deciding the decision-making problem to be conducted, selecting suitable consideration dimensions and factors for the target decision-making so as to establish the hierarchy structure of evaluation.
2. Conduct pairwise comparison: Once the hierarchy structure is established, adopting the nine scale of pairwise comparison between dimension layer and each factor layer to conduct pairwise comparison for the ranking of each consideration element. Further, converting the scores into triangular fuzzy semantic membership functions. The conversion of pairwise comparison scale is shown in Table 1.

Table 1: Pairwise Comparison Scale and Triangular Fuzzy Numbers Conversion

Scale	Definition	$F_{ij}=(L_{ij}, M_{ij}, R_{ij})$
1	Equal importance	$1' = (1, 1, 3)$
3	moderate importance	$3' = (1, 3, 5)$
5	strong importance	$5' = (3, 5, 7)$
7	demonstrated importance	$7' = (5, 7, 9)$
9	extreme importance	$9' = (7, 9, 9)$

3. Build matrix of pairwise comparison: On the upper triangular part of the pairwise comparison matrix, placing the comparison score for a group of dimensions and factors made up of $A1, A2, A3, \dots, An$. Further, the reciprocal number of the score for the relative position on the lower triangular part is considered, namely, $a_{ij}=1/a_{ji}$, where a_{ij} represents the relative priority of dimension/factor i to dimension/factor j .
4. Convert each matrix value into the triangular fuzzy numbers: Following Table1, converting each value in the pairwise comparison matrix into the triangular fuzzy numbers (F_{ij}), where $F_{ij} = (L_{ij}, M_{ij}, R_{ij})$ is the fuzzy number of dimension/factor i to dimension/factor j .
5. Calculate the fuzzy local weights of each dimension and factor: After obtaining the overall triangular fuzzy numbers of all dimensions and factors, the mean of these triangular fuzzy numbers is further calculated to obtain the mean $L_i, M_i,$ and R_i of the fuzzy numbers. Finally, calculating the triangular fuzzy local weights $L'_i, M'_i,$ and R'_i of each consideration element.
6. Obtain defuzzify value and normalization weight: After obtaining the triangular fuzzy local weights in the step 5, we defuzzify the triangular fuzzy local weights and convert them into a real number DW_i , then set the sum value DW_i of all dimensions and factors as 1.0. Next, conducting normalization to obtain the final fuzzy local weight (LW) DW'_i of each consideration element.
7. Determine the priority of each consideration factor: Subsequent to the steps above, the triangular fuzzy local weights of each dimension is then multiplied by the triangular fuzzy local weights of all factors under the same dimension, so that an triangular fuzzy global weights is obtained for each factor. Further, defuzzifying these triangular fuzzy global weights and conducting normalization to obtain the final fuzzy global weight (GW) of each factor. Finally, the priority of each consideration factor in the decision-making problem can be determined by reviewing the GW of the factor.

RESEARCH METHOD

In this study, interviews with operators of multiple domestic middle- and small-scaled pure e-Commerce businesses were first conducted, and a variety of information obtained from the interviews was summarized and compiled to get a preliminary understanding of the difficulties currently encountered by the e-Commerce businesses in their operation. Further, an evaluation element hierarchical framework was established based on the concluded pain points of the e-Commerce businesses; and FAHP method was used to analyze what critical consideration factors are deemed important or concerns to the pure e-Commerce businesses when they face the issue of whether to transform into the “new retail” operating model in the future.

Selection of Consideration Elements

From the results of interviews mentioned above, it was found the major considerations of e-Commerce businesses for transforming from the current operating model into a new operation pattern should include what bottlenecks in existing operation can be improved through the transformation, what benefits can be brought to the business by the transformation, and what risks are to be undertaken for the transformation. In view of this fact, the content of interviews with the pure e-Commerce businesses, the study on the evaluation of tangible benefits, intangible benefits and risks to business electronic operation conducted by Irani & Love (2000) and Shang & Seddon (2002), and the value-based adoption model proposed by Kim et al. (2007) based on the cost-benefit theory were taken in this stage as a reference to classify the benefits from transforming pure e-Commerce into new retail into 5 major dimensions, namely, “market benefit”, “economic benefit”, “brand benefit”, “marketing benefit” and “cost consideration”.

Through compilation and summarization of literature and based on the pain points of existing e-Commerce businesses in running e-Commerce, this study selected total 27 consideration factors under the 5 major dimensions. By setting the analysis objective of this study to the exploration of “consideration factors deemed important to the pure e-Commerce businesses in their future transformation into new retail operation pattern”, all of the consideration factors are defined below, as shown in Table 2.

Table 2: Definitions of Consideration Factors for Transforming into New Retail

Dimension	Consideration Factor	Definition
D1 Market Benefit	C1.1 Increase stock turnover	Sales channels can be increased to upgrade sales amount and enable higher stock turnover after transforming into new retail.
	C1.2 Decrease unnecessary stockpile	The demands of all possible customers and sales channels can be more precisely understood and controlled after transforming into new retail and accordingly, different purchase and stock strategies can be set to decrease unnecessary stockpile.
	C1.3 Precisely understand market price fluctuation	The fluctuation in product market prices can be more precisely understood and controlled after transforming into new retail to thereby reduce the occurrence rate of having a sales amount lower than the purchase cost.
	C1.4 Increase produce sales channels	Products can be sold without being limited to only online channels any longer after transforming into new retail.

	C1.5 Create opportunity for cross-industry cooperation	Physical stores can be expanded after transforming into new retail to enable cooperation with cross-industry traders, such as having stocks consigned in the stores of other traders for tie-in sales with other traders' products.
	C1.6 Develop customer's potential market	After transforming into new retail, more potential customers or customers who did not trust online shopping can come to offline physical stores for product experience or product consultation and even buying products.
D2 Brand Benefit	C2.1 Strengthen brand competitiveness	The own-brand competitiveness can be increased after transforming into new retail for customers to first consider it when they want to purchase a certain type of product.
	C2.2 Create brand topicality	The own-brand could become more topical after transforming into new retail and often be the first brand that the customers think of when they are talking about a certain product with friends.
	C2.3 Increase brand attraction	The own-brand would be more attractive to customers after transforming into new retail and get their immediate attention to the information about sales promotions and newly launched products.
	C2.4 Increase brand awareness	The own-brand can have increased awareness after transforming into new retail, and all customers would know the brand as soon as they hear of it.
	C2.5 Shape brand positioning	The positioning of own-brand in customers' mind can be strengthened after transforming into new retail, such as being a 3C specialty store or a clothing specialty store.
	C2.6 Increase brand exposure	The own-brand would have increased exposure after transforming into new retail, and offline stores can be living signboards to expose own-brand to more customers.
	C2.7 Increase the number of members	In addition to keeping the original online customer members, more offline new customer members can be increased after transforming into new retail.
D3 Economic Benefit	C3.1 Reduce reverse logistics costs	After transforming into new retail, customers can come to the offline stores to really contact with the products, which can largely reduce the situation of receiving non-expected or malfunctioned product. Customers may also come to the offline stores to settle any product exchange and product return, which would reduce the cost of reverse logistics.
	C3.2 Reduce intermediate costs	After transforming into new retail, the business owner no long needs to pay a high amount of intermediate costs to the B2B2C platforms for selling and advertising products on the platforms.
	C3.3 Shorten payment collection cycle	After transforming into new retail, customers have the option of directly coming to the offline stores to pay and pick up their products, which would shorten the time of payment collection.
	C3.4 Set product prices independently	After transforming into new retail, the business owner can independently set the sales prices of products sold online and offline according to the existing market condition; and can adjust the prices according to changes in the market from time to time to make a quick response to the market.
	C3.5 Increase revenue	After transforming into new retail, products can be sold via multiple online and offline sales channels to increase revenue.
D4 Marketing Benefit	C4.1 Increase product mix	After transforming into new retail, more types of product mix can be considered, such as buy product A and get product B free, so as to attract more consumers.
	C4.2 Provide consumers with value-added services	After transforming into new retail, more types of value-added services can be provided, such as come to check in and experience product to get one discount coupon, so as to enhance consumers' stickiness to the products.
	C4.3 Provide product differentiation	After transforming into new retail, it is able to highlight how the own-products are different from other e-Commerce products by, for example, providing customers with real product experience, using teaching, etc.
	C4.4 Enhance product advertising effect	After transforming into new retail, the advertising of specific products can be reinforced via the offline stores, such as sending DM of hot sale products or making advertising posters.
D5 Cost Consideration	C5.1 Increased labor costs	The transforming into new retail channel model necessitates hiring of more employees for managing all the online and offline channels, such as store staff and warehouse workers.
	C5.2 Increased advertising and marketing costs	The transforming into new retail channel model necessitates additional advertising and marketing costs for products sold on offline channel, such as holding sales promotions at physical stores.
	C5.3 Increased operational costs	The transforming into new retail channel model necessitates additional expenses for operating the physical stores, such as utility costs, store rent and

		equipment cost.
	C5.4 Increased management costs	The transforming into new retail channel model necessitates additional expenses for managing the offline physical channel, such as supervising all physical stores and the divisions thereof and integrating all online and offline resources.
	C5.5 Increased logistics costs	The transforming into new retail channel model necessitates additional payment to increased logistics services of, for example, transporting products from a warehouse to the physical stores or redeploying and transporting products between any two physical stores.

ANALYSIS RESULT

Descriptive statistical analysis

In this study, every expert participated in the questionnaire interviews is an operator of a domestic middle- or small-scaled pure e-Commerce business. All the interviewed experts have more than ten years of experience in running and managing e-Commerce; and they are currently operators or managers of a certain e-Commerce brand. Besides, a majority of these e-Commerce businesses do not provide consumers with physical services, such as product trial use and in-store sales. A total of 15 experts participated in the questionnaire interviews in this study. Table 3 shows the demographic statistics information of these experts.

Table 3: Demographic Information of Experts

Item	Sub-item	Count	Percent
Gender	Male	11	73.3%
	Female	4	26.7%
Age	36-40	5	33.3%
	41-45	6	40.0%
	46-50	3	20.0%
	Over 50	1	6.7%
Main items of business	Computers and Peripheral Equipment	6	40.0%
	Electronic Parts and Components	2	13.3%
	Communication Equipment	3	20.0%
	Wearing Apparel and Clothing Accessories	4	26.7%
Position	Chief Executive Officer	3	46.7%
	General Manager	5	20.0%
	Manager	7	33.3%

FAHP Analysis

In this study, all of the experts participated in the interview were required to complete a questionnaire using 1-9 score of pairwise comparison scale proposed by Saaty (1990); and each expert was requested to make the pairwise comparison for both of the dimension level and the factor level. In addition, to ensure the questionnaire's validity, the consistency test was applied in this study to check whether the consistency index (*C.I.*) and the consistency ratio (*C.R.*) of each question are passed the test, so as to guarantee the consistency of answers from each expert to the questions (Saaty, 1990). If there were any answers that failed to pass the test of consistency, the expert was requested to refill the questionnaire again. The formula of *C.I.* is explained as follows:

$$C.I. = \lambda_{max} - n / n - 1 \quad (1)$$

where λ_{max} is the maximum eigenvalue of each pairwise comparison question, and n is the number of the hierarchical consideration factors.

Saaty (1990) suggests $C.I. \leq 0.1$ is more ideal. However, when the decision problem becomes complicated, the number of hierarchy in the matrix would increase accordingly. As a result, it will be more challenging to verify the consistency of pairwise comparison result. Considering this issue, the "random index" (*R.I.*) is proposed by Saaty (1990) as shown in Table 4, to adjust the changes of different *C.I.* values in different hierarchies, which was known as, "consistency ratio" (*C.R.*).

Table 4: Random Index of Consistency

Number of level factors (n)	1	2	3	4	5	6	7
R.I. value	0.00	0.00	0.58	0.90	1.12	1.24	1.32

Saaty (1990) also suggested that $C.R. \leq 0.1$ is better, it indicates that the consistency of pairwise comparison is dependable. The formula of *C.R.* is shown as follows:

$$C.R. = C.I. / R.I. \quad (2)$$

After all the questionnaires passed the test of consistency, this study further conducted the FAHP method to analyze the scores of each questionnaire. Through the FAHP analysis, a triangular fuzzy number was obtained for each of the consideration dimensions and the consideration factors. After the process of defuzzify and normalization, the fuzzy local weight (LW) of each consideration element was calculated. Further, the LW of each dimension was multiplied by the LW of each of the factors under the dimension to thereby obtain the fuzzy global weight (GW) of each consideration factor in the whole hierarchy structure of evaluation. Then, according to the GW, the priority of consideration factors was ranked. The results of the FAHP analysis are shown in Table 5.

Table 5: Weights and Priority of Dimensions and Factors

Elements	Lower score	Middle score	Upper score	De-fuzzy value	LW	Local rank	GW	Global rank
D1 Market Benefit	0.108	0.257	0.795	0.387	0.270	1		
D2 Brand Benefit	0.068	0.193	0.582	0.281	0.197	3		
D3 Economic Benefit	0.081	0.285	0.787	0.384	0.269	2		
D4 Marketing Benefit	0.036	0.098	0.346	0.160	0.112	5		
D5 Cost Consideration	0.048	0.168	0.438	0.218	0.152	4		
C1.1 Increase stock turnover	0.113	0.301	0.834	0.416	0.304	2	0.082	3
C1.2 Decrease unnecessary stockpile	0.038	0.087	0.305	0.143	0.105	4	0.028	15
C1.3 Precisely understand market price fluctuation	0.027	0.072	0.223	0.107	0.078	5	0.021	21
C1.4 Increase produce sales channels	0.044	0.127	0.388	0.186	0.136	3	0.037	9
C1.5 Create opportunity for cross-industry cooperation	0.022	0.059	0.186	0.089	0.065	6	0.018	23
C1.6 Develop customer's potential market	0.125	0.355	0.802	0.427	0.312	1	0.084	2
C2.1 Strengthen brand competitiveness	0.074	0.188	0.614	0.292	0.205	1	0.040	7
C2.2 Create brand topicality	0.033	0.083	0.310	0.142	0.100	6	0.020	22
C2.3 Increase brand attraction	0.046	0.130	0.400	0.192	0.135	5	0.026	18
C2.4 Increase brand awareness	0.048	0.156	0.383	0.196	0.137	4	0.027	17
C2.5 Shape brand positioning	0.018	0.052	0.161	0.077	0.054	7	0.011	26
C2.6 Increase brand exposure	0.063	0.197	0.575	0.278	0.195	2	0.038	8
C2.7 Increase the number of members	0.060	0.194	0.490	0.248	0.174	3	0.034	11
C3.1 Reduce reverse logistics costs	0.112	0.254	0.643	0.337	0.267	2	0.072	4
C3.2 Reduce intermediate costs	0.043	0.108	0.286	0.145	0.115	3	0.031	13
C3.3 Shorten payment collection cycle	0.023	0.043	0.116	0.061	0.048	5	0.013	25
C3.4 Set product prices independently	0.035	0.091	0.284	0.137	0.108	4	0.029	14
C3.5 Increase revenue	0.217	0.505	1.023	0.581	0.461	1	0.124	1
C4.1 Increase product mix	0.090	0.213	0.599	0.301	0.235	3	0.026	19
C4.2 Provide consumers with value-added services	0.049	0.109	0.299	0.152	0.119	4	0.013	24
C4.3 Provide product differentiation	0.172	0.426	0.937	0.512	0.399	1	0.045	6
C4.4 Enhance product advertising effect	0.104	0.252	0.597	0.318	0.248	2	0.028	16
C5.1 Increased labor costs	0.098	0.184	0.524	0.269	0.232	2	0.035	10
C5.2 Increased advertising and marketing costs	0.061	0.125	0.351	0.179	0.155	4	0.024	20
C5.3 Increased operational costs	0.096	0.183	0.454	0.244	0.211	3	0.032	12
C5.4 Increased management costs	0.231	0.462	0.508	0.400	0.346	1	0.053	5
C5.5 Increased logistics costs	0.027	0.047	0.119	0.064	0.056	5	0.008	27

CONCLUSION

This study summarized the pain points encountered by the pure e-Commerce operators in running their e-Commerce businesses; and took the cost-benefit theory as a reference to build the evaluation hierarchical framework of this study. Further, the FAHP method was applied to conduct data analyses in order to understand the consideration factors of the current pure e-Commerce businesses for transforming into the new retail omnichannel OMO operating model.

As can be found from the analysis results of this study, "D1 Market Benefit (0.270)" and "D3 Economic Benefit (0.269)" are the two consideration dimensions most important to the e-Commerce businesses for transformation into new retail model. Besides, as can be seen from Table 5, the sum of the GW of the top seven key consideration factors (C3.5 Increase revenue, C1.6 Develop customer's potential market, C1.1 Increase stock turnover, C3.1 Reduce reverse logistics costs, C5.4 Increased management costs, C4.3 Provide product differentiation, and C2.1 Strengthen brand competitiveness) accounts for more than 50% of the total GW. It indicates that these factors have a great influence on the pure e-Commerce businesses in their future transformation into New Retail Omnichannel operating model.

It is found from the above analysis results that, in the event a pure e-Commerce business considered adopting the omnichannel sales model, what it cares is whether it can attract more potential consumers to know and get contact with its own brand and attract consumers to its physical stores to try and experience the products they are interested in and even buy the products, so as to increase its sales volume and accordingly, earn higher revenue. Meanwhile, the pure e-Commerce businesses also hope the transformation into the new retail operating model could encourage customers to return and exchange products at the physical stores to thereby largely reduce the reverse logistics expenses that were undertaken by the businesses in the case of e-Commerce. However, the pure e-Commerce businesses were also concerned that the adoption of OMO operating model might require a huge amount of management expenses, such as the expenses for supervising physical stores and integrating online and offline resources.

The results from this study provide the pure e-Commerce businesses with considerably useful reference in the issue of new retail. In future studies, more decision making analysis approaches, such as DEMATEL and ANP, can be used in combination to analyze the attitude of e-Commerce businesses of different business items, such as consumption electronic products, garments, computers and peripherals, towards the key consideration factors they deem important or are concerned in future transforming into new retail operating model, and to see how the difference is among the consideration factors of these e-Commerce businesses of different business items.

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Exploration the future of the metaverse and smart cities

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ABSTRACT

The year 2021 is being called the first year of the metaverse which has been in the spotlight for more than a year. According to a report published on the website of the Spanish newspaper "The Economist", the metaverse is one of the most important technology trends in 2022. From the listing of Roblox on NASDAQ in the United States as the "first Metaverse stock", to the creation of a "Metaverse city" in Seoul, and then to the "inter-temporal interviews of Metaverse" conducted at the two sessions of the National Assembly in China. The discussion on metaverse has gradually expanded from the interpretation of the concept to the possibilities of related applications, and has shown a trend of diversification in terms of topics and subjects. Although metaverse research has become a popular research field in academic circles at home and abroad for less than a year, with the joint efforts of many scholars in many disciplinary fields at home and abroad, academic research on metaverse has made considerable progress with some innovative research findings. Metaverse is moving from conceptual construction and theoretical exploration to the rapid development stage of practical exploration and industrial application in parallel. From the perspective of the current situation of metaverse research, this paper systematically compares the hot spots of metaverse research at home and abroad, and on this basis, prospectively thinks about and explores the future trend of the integration and development of metaverse and smart cities, in order to provide some theoretical reference and inspiration for the current research of metaverse and smart cities.

Keywords: Metaverse, smart cities, development, virtual world, technology.

INTRODUCTION

Recently, the metaverse has exploded on the Internet field and is rapidly spreading to other fields. Many domestic and foreign technology companies are setting up in metaverse-related fields. For example, as early as March 2021, the "Sandbox" game platform "Roblox" included the metaverse concept in its prospectus for the first time, listed on the New York Stock Exchange in the United States, the closing price rose 54% on the first day and the market value exceeded 40 billion US dollars, becoming a "dark horse" in the international stock market, which has led to the strong rise of related metaverse technology concept stocks at home and abroad. In July 2021, Satya Nadella, Chairman and CEO of Microsoft, expressed his commitment to "build the enterprise metaverse". In October 2021, Facebook CEO Mark Zuckerberg announced the creation of "metaverse" product team, and later updated the name of the parent company to "Meta". In December 2021, Baidu released the first metaverse product "XiRang" in China; in addition, ByteDance relied on its huge product matrix to invest in the metaverse field; Tencent taken advantage of its design + content to layout the metaverse field; NVIDIA launched the Omniverse real-time simulation and collaboration platform for enterprises to build a shared virtual three-dimensional world, and game companies such as NetEase, MiHoYo and ZQGame are also laying out the metaverse field. Leading international consulting firms, represented by Bloomberg and PricewaterhouseCoopers, are bullish on the development and future of the metaverse. According to Bloomberg, the metaverse market will reach \$800 billion by 2024, while PwC estimates that the metaverse market will reach \$1.5 trillion by 2030. The metaverse-related topics are rapidly breaking the circle, and the market and social attention are extremely high. This shows that metaverse has become one of the hot topics in the society due to the attention of the society as soon as it appears. The era of "metaverse" is not in the future, but in the present.

THE ORIGIN AND CONCEPT OF THE METAVERSE

Source and Development of the Metaverse

The term "Metaverse" first appeared in the 1992 science fiction novel "Snow Crash" by the famous American science fiction writer Neal Stephenson, which refers to a three-dimensional space that is detached from and parallel to the real world. Users can live and work in the virtual world through "avatar" digital images, realizing online virtual world interaction. Through the publicity of "Snow Crash", a virtual network world parallel to the real world, the "metaverse", was gradually accepted by science fiction writers. The book's vision of a virtual technological society opened the door to the imagination of people. However, neither the author nor the reviewer could have foreseen that thirty years later the concept of the metaverse presented in this book would create a powerful shockwave.



Source: This study.

Figure 1: Development timeline of the Metaverse

The metaverse was gradually established in science fiction films, and another virtual world was described in 1999's "The Matrix". Tron, released in 2010, refined and described the previously mentioned virtual world in more detail. The concept of the metaverse became well known to the public through the science fiction film "Ready Player One" directed by Spielberg, in which the metaverse becomes part of a future human society, and those who are unmotivated in reality use the metaverse to vent and express themselves. The metaverse has also been fully reflected in many games, such as, in 2003, Linden Lab's game "Second Life", which describes a groundbreaking and phenomenal virtual world where players can socialize, shop, build and do business. It is no longer just a game, but has a richer and more developed virtual economic system. For example, "Ninth City", "My World", "Village of Hope", "Second Galaxy" and other metaverse concepts are in full swing. Since the birth of the metaverse, the metaverse scene has been continuously refined and deepened (Figure 1). The ideal metaverse is no longer

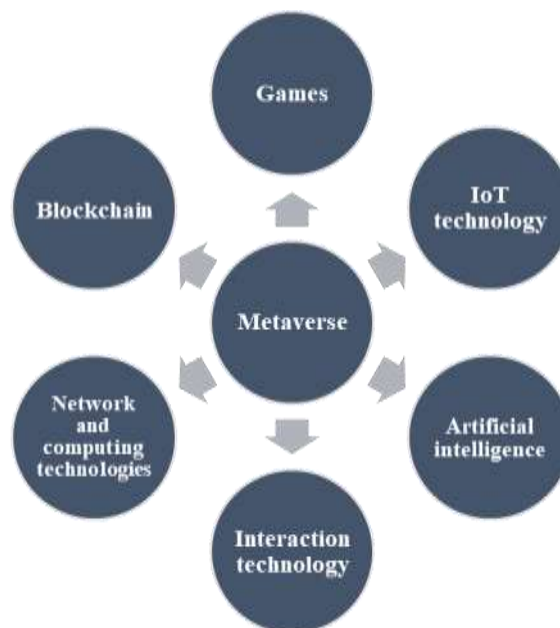
limited to entertainment, commerce, and social, but is more likely to be infinite in scope, and these systems form a relatively complete society with each other.

Concept of the Metaverse

There is no unified concept of what the "metaverse" is, and the Internet giants have different interpretations. Mark Zuckerberg's "metaverse" is a combination of the real and the virtual, making the world less distant. NVIDIA's "metaverse" is to move the real world into the virtual world, to improve the planning and practical efficiency of the industry through complete replication. MiHoYo's vision of the 'metaverse' is the continuation of a living society. Roblox sees the "metaverse" as consisting of eight elements: identity, friends, immersion, low latency, diversity, anywhere and anytime, economic system, and civilization. The "metaverse" is a virtual space parallel to and independent of the real world, an online virtual world that maps the real world, and an increasingly realistic digital virtual world.

The New Media Research Center of School of Journalism and Communication of Tsinghua University published a research report on the development of metaverse from 2020 to 2021, which gave a relatively regular definition of "metaverse": the so-called metaverse refers to a new type of Internet application and social form that integrates virtual space technology, artificial intelligence technology, interaction technology, blockchain technology and other new technologies. It is based on extended reality technology to provide immersive experiences, and digital twin technology to generate a mirror image of the real world, and blockchain technology to build an economic system that closely integrates the virtual world with the real world in the economic system, social system, and identity system, and allows each user to produce and edit content. With the explosive growth of cyberspace and the rapid development of extended reality devices, especially under the influence of COVID-19, virtual space offers the possibility of socialization, making the boundary between physical and virtual space increasingly blurred.

"The metaverse is not a technology per se, but an idea and a concept that requires the integration of different new technologies, and the main core technologies of the 'metaverse' are the following (Figure 2).



Source: This study.

Figure 2: Overview plot of metaverse.

Games: the initial landing scene for the metaverse

The game is widely considered to be the initial gateway to the metaverse, giving players a virtual identity, and players can rely on this identity to socialize within the game, which taking on the beginnings of a metaverse.

Blockchain: the underlying architecture to achieve a decentralized economic system

The metaverse requires the construction of its own independent economic system. Blockchain technology can realize the flow of value within the metaverse through smart contracts, and guarantee the transparent and efficient implementation of system rules.

Network and computing technologies: 5G/6G and edge computing for low latency

The metaverse requires high synchronization and low latency so that users can have a perfect experience in real time and smoothness. The metaverse requires rapid transmission of large amounts of data and relies on a strong communication infrastructure. Limited by the number of base stations, the actual transmission rate of 5G may be difficult to reach its design

level, while according to the Japanese and Korean outlook on 6G network technology, 6G latency is expected to be reduced to one-tenth of 5G and transmission rate is expected to reach 50 times of 5G, which is expected to truly realize the key feature of low latency in the metaverse. In addition, edge computing is often considered a key infrastructure of the metaverse, which helps end users to replenish local computing power, improve processing efficiency, and minimize the risk of network latency and network congestion by adopting an open platform near the source of data and providing the nearest end of the service directly nearby.

Interaction technology: improve user immersion, metaverse must go through

From the early mouse and keyboard to the current VR/AR devices, the operation mode of the game continues to evolve. Through a variety of devices such as body suits and fully automatic haptic chairs, which collect player information and output feedback information to players in real time, players have a more realistic sense of mapping in the virtual space, thus gaining an immersive experience. The ultimate form of development is to realize perceptual experiences such as smell and taste through brain-computer interface technology, while freely interacting with the virtual world, significantly enhancing the realistic experience and immersion.

Artificial intelligence: a supporting technology for building virtual worlds

The development of computer vision, machine learning, natural language processing and intelligent speech have provided the metaverse with a combined virtual and realistic view, making the metaverse with diversity and immersion.

IoT technology: meeting the demand for diversified ways to access the metaverse

IoT technology can meet the requirements of accessing the metaverse in various ways anytime and anywhere, while providing support for the metaverse to sense external sources of information. One of the requirements of the metaverse is easy access, so the way people interact with the Internet will not be limited to mobile phones and computers, but various wearable devices, cars, homes, etc. will be connected to the network. In addition, IoT sensors are an extension of the human senses, which can ensure that the metaverse world captures more information about the outside world.

CURRENT RESEARCH AND APPLICATIONS OF METAVERSE

The Study of Metaverse

Since the first year of the Metaverse in 2021, scholars at home and abroad have conducted extensive research on metaverse, which mainly covers three aspects (Table 1).

Table 1: Research on metaverse.

Research Themes	Research Content	Representative Studies
The study of the metaverse ontology	It mainly refers to research on the concept, mode, technology and other aspects of the metaverse, which is the main topic of interest for scholars in the early years.	Wright et al. propose that metaverse constitutes a new type of augmented reality interaction space through the contact and overlap of numerous nodes in the virtual and the real. Lingzhi Fang et al. argue that metaverse is the inevitable trend of social informatization and virtualization is the ultimate stage of Internet development.
Theoretical study of the metaverse	It mainly refers to study of the specific representation in the metaverse of theoretical models constructed in traditional settings.	(a) Conducting research from two main subjects, users and information, can help improve the understanding of the information behaviour of metaverse users and thus facilitate the promotion of metaverse applications. (b) Comparing the governance structures of four different levels of interconnection based on incomplete contract theory can provide policy recommendations for metaverse governance through the analysis of the optimal order of the metaverse.
Applied research of the metaverse	It primarily refers to the study of the impact of the formation and development of the metaverse in various fields.	The application of metaverse in education, entertainment, business, politics and other scenarios has been widely explored by scholars at home and abroad. However, most of the existing studies have been discussed at the level of theoretical framework, and there is a relative lack of research exploring the path of metaverse realization from the perspective of needs.

Source: This study.

Application of Metaverse

Recently, the "metaverse" has become the new favorite of the industry and capital market. A large number of companies claiming to switch to the "metaverse" and various capitals pouring in. The "metaverse" has instantly become a new hot spot in the Internet industry.

At present, the development of "metaverse" technology is still in its infancy, and it is necessary to take a rational and pragmatic view of the application of "metaverse" technology and the changes that may be brought about by its future development. The application of metaverse is a process that will continue to deepen with the development of technology. In the short term, providing immersive experience services for users in the fields of social entertainment, cultural and tourism activities, education and training will be the main application scenarios of "metaverse" technology. In the medium term, providing technology simulation platform for technology research and development will probably be the main application scenario of "metaverse" technology. In the long term, advanced exploration research in life sciences, material sciences, marine sciences, earth and space sciences, and information sciences will likely be an important use of "metaverse" technology. The "metaverse" can upgrade the existing industry formats. From "Internet+", "Big Data+", "Artificial Intelligence+" to "Metaverse+", the development and application of "metaverse" technology will definitely bring about a revolution in the mode of integration of information technology and economy and society.

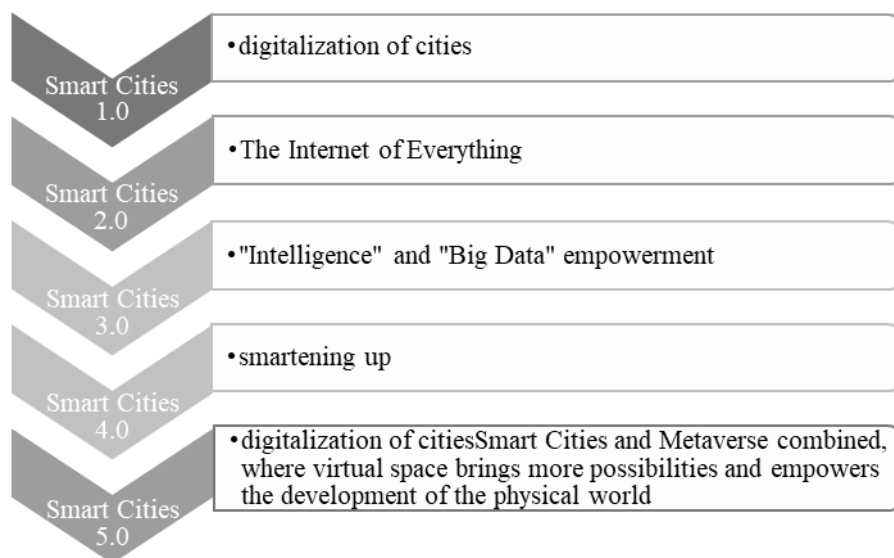
The development and promotion of "metaverse" technology requires consideration of various factors. Firstly, in the process of expanding the "metaverse" scenario, it is necessary to dig deeper into the "metaverse" application scenarios that have the effects of technology application substitution and service comprehensiveness. Do not ignore user experience, social value, economic value and regulatory boundaries without understanding the needs. Secondly, it is important to strengthen technological innovation. The emergence of "metaverse" is the result of information technology development and application innovation, so we should continue to innovate in information perception, data processing, data modeling, software definition, virtual reality simulation, scene rendering, artificial intelligence, information security and other related technological innovation, and promote the in-depth integration and application of related technologies in the metaverse environment. Thirdly, in addition to social value, the development and application of "metaverse" technologies must consider the economic value of the application of practical scenarios, and need to take into account both short-term and long-term input-output ratios.

EXPLORE THE NEW WAYS OF METAVERSE AND SMART CITIES

The root cause of the metaverse explosion is that it brings unlimited imagination to people. The boom of smart cities construction is in the ascendant. The explosion of the metaverse concept will certainly inject new vitality into smart cities, open up more application scenarios for smart cities and push them forward. The metaverse is a completely new concept, and there are still too many unknowns and uncertainties about its development direction after combining with smart cities. However, there is no doubt that the combination of smart cities and metaverse is an inevitable trend. This paper discusses the issues involved in the evolution of metaverse and smart cities, future technologies and future application scenarios.

The Development History of Smart Cities

The current smart cities can be divided into four stages according to its degree of development, and will enter the fifth stage in the future (Figure 3).



Source: This study.

Figure 3: Development stage of smart cities.

Advantages of Metaverse Applied to Smart Cities

From digitalization to intelligence to wisdom, the integration of cutting-edge technologies and smart cities has become inevitable, and technology has become an important means to enhance the effectiveness of smart cities. How to use metaverse technology is a new trend in the construction and development of smart cities (Figure 4).



Source: Baidu pictures.
 Figure 4: Metaverse and smart cities.

Since users in the metaverse will interact in the digital space as virtual images, a large number of problems in the real world can be avoided. The advantages of metaverse applied to smart cities include: (1) better accessibility, so that users in different physical locations can enjoy the same information and experience; (2) better diversity, so that different user groups can enjoy a space to get along with each other free from physical resources; (3) better equality, so that users of different races, colors, and languages can enjoy equal opportunities for development; (4) better humanity, so that human culture to be passed on in a more healthy and perpetual way. More importantly, the metaverse may be an important infrastructure for future technological innovation.

Application of Metaverse in Smart Cities
Urban planning and construction

The metaverse can improve scientific planning and smart construction of cities (Figure 5). The metaverse is a natural, dynamic and scientific virtual experiment site that provides an operable path for realistic smart cities construction. Using real city information and social multi-dimensional data to replicate the city in the metaverse, city residents are invited to live virtually in a city with different scenarios to flexibly preview planning effects and to discover planning problems and defects in advance, so that multiple scenarios can be compared, researched, optimized and selected. After determining the suitable planning scheme for the city, the city builder can present the details of the public facilities layout, building structure, greenery planting, etc. of the city construction in the metaverse before the construction starts, and even deduce the possible urban problems that may arise during the construction process for the reference of engineers, builders and managers, and create a precise, dynamic, stakeholder-engaged and sustainable smart cities.



Source: Baidu pictures.
 Figure 5: Urban planning and construction in metaverse.

Economic development

Through the coordinated development of the metaverse and the smart city, the virtual goods of the metaverse can, to a certain extent, not only replace the goods in the physical world, but its functionality even exceeds that of the goods in the physical world. The goods in the metaverse thus developed have a huge imagination, so that the total economic volume will no longer be only the quantity of the physical world, but also add the scale of the metaverse economy. Moreover, the pollution and carbon emissions of the physical world would be mitigated to some extent by the partial substitution of the metaverse. Thus the metaverse economy will expand and contribute to the economic development of smart cities (Figure 6).



Source: Baidu pictures.

Figure 6: Economic development in metaverse.

Daily life and education

Life and education in the physical world will be partially transferred to the metaverse and smart cities. With the development of smart cities, people's travel will gradually decrease, and many tasks can be done at home. As a result, transportation will be improved, and the use of water, electricity, gas, etc. will become more predictable. The knowledge and culture of the real world will be reflected in the metaverse, and the new knowledge and culture will be created in the metaverse. The development of the metaverse and smart cities will bring a new way of life and unprecedented experiences to humanity.

Smart City Operations and Emergency Events

The metaverse is a virtual space that runs parallel to the physical world. As a mapping of the physical world, it has the function of simulating the operation of the city. Problems that we cannot perceive or capture in the real world are more easily to be detected in the virtual world, and thus get early warning. In the metaverse, the simulation of urban production, management and other issues, allowing people to anticipate the development of situation and thus make scientific decisions; it simulates real emergency events such as earthquakes, fires, floods and viruses, etc., truly reflecting the tense and critical real scenes in emergency events and the immediate response of personnel, strengthening urban emergency response capabilities and urban resilience. For example, the current global COVID-19 epidemic facing the world, through the metaverse and smart city system, can better deploy epidemic prevention measures to bring the epidemic under control as early as possible.

Future Technology Outlook of Metaverse and Smart Cities

The metaverse and smart cities have unlimited potential for development, but they also depend on the support of future technologies (Figure 7). Current promising future technologies include: 1. Computing platforms, such as quantum computing and biocomputing, etc., provide arithmetic support for the continued development of the metaverse. A metaverse city is an interconnected space, and interconnections in future metaverse city will be more efficient than current networks. However, the network in the metaverse relies on the network of the physical world. At the same time, the communication between the metaverse and the physical world also depends on the network of the physical world. China's 5G network technology and network construction have been in the world's leading position, which has laid a good foundation for the development of metaverse cities, but 5G technology can only support the beginning of the metaverse, and in the subsequent development stages of the metaverse, the requirements for the network will be substantially improved essentially higher. 2. Brain-machine interface, the maturity of brain-machine interface technology means not only the connection between the brain and the machine, but also means that the machine can read, understand and even store the information of the brain, the significance of which is self-evident.



Source: Baidu pictures.

Figure 7: Metaverse technology and smart cities.

The promotion of metaverse to smart city

For the "metaverse", which highly virtualizes the world, social, economic, political, cultural and living systems in human civilization will gradually shift to the virtual world. By extension, the virtualized and digitalized products derived from the diversified applications of various industries will affect the development of the entire "metaverse" world. In a nutshell, the "metaverse" will profoundly change the organization and operation of the existing society by integrating the virtual and the real, forming a new way of life with both virtual and real, and giving rise to a new type of smart city that is integrated online and offline.

- The development of metaverse technology is conducive to the development trend of multi-governance of smart cities. In the metaverse, diversified urban subjects can observe, participate and experience various aspects of urban planning, urban construction, urban management and urban operation from different perspectives, simulating the gaming and cooperation process of each subject in urban operation, presenting an urban operation model that approximates the real world, and discovering the inner connections and laws, implicit order and influence mechanism of cities and people. Even city residents can create their own ideal cities and apply their own urban governance solutions in the metaverse. City policy makers and managers can then bring together the wisdom of the people to take advantage of their strengths, optimize urban construction and innovate urban governance models. The metaverse emphasizes human participation, and people can add new dimensions and domains in the meta-universe to extend the real physical world and create virtual worlds, which helps cities to improve and adaptively optimize, provides accurate and realistic experimental data and governance basis for real- world smart cities, and provides solutions to dilemmas encountered in smart city construction.
- The realistic nature of the metaverse makes it convenient for virtual-real interaction in the realization of smart cities. The metaverse replicates reality in the virtual, and the realization of scenario functions such as ready login, low latency, immersion, strong sociality, free trade, and free creation makes it possible to build a realistic human society in the metaverse. All city issues can be fully mapped in the metaverse, and managers and city residents can live in it. A stable monetary system, a pluralistic cultural system, a free and open social environment, and immersive user participation in the metaverse are the basic operational framework of human society. In this framework, city residents can participate in the virtual- real interaction and interactive feedback of the urban system at multiple levels through the changes in space and time in the virtual city. By observing the dynamics of events in the meta universe, we can discover the changes of situation in advance, simulate the problem disposal process, and provide a feasible pre-treatment scheme for the real world. So as to formulate the overall optimal response strategy for the urban problems in the real world in advance, and realize the overall unified scheduling and collaborative governance of the city.

CONCLUSION

The focus of smart cities is on smart driving, restructuring smart technologies and governance scenarios to alleviate urban problems so as to achieve harmonious coexistence between people and cities. Metaverse technology plays an important role in promoting the development of smart cities. Exploring the intelligent governance of "metaverse + smart city" carries human thinking about urban governance model and the vision of the future shape of the city. The metaverse provides a step-by-step path for human imagination of the future city. It should be pointed out that the metaverse is still in its initial stage. On the one hand, the full realization of the metaverse requires further technological improvement, strengthening the integration and complementation of multiple technologies and smart cities, and reasonably grasping virtual and reality. On the other hand, in a technology-driven smart city, people play a leading role in the application of technology. However, due to differences in human thinking, cognition, and interests, there is often significant uncertainty and ambiguity in the application of technology. How to coordinate the relationship between people, technology and cities in smart cities is a topic worthy of in-depth study. At present, the concrete realization path of metaverse and smart cities is still in the exploration stage, and there is still a long way to go in the future.

At this stage, the "metaverse" is still in the stage of exploration and experimentation. "Metaverse" is more of a concept for various application areas, which needs to be studied and researched, and deeply understood and innovated in the process of practice. A large number of high-tech companies have already invested large amount of money on research and development to prepare for the technology. The development of metaverse and smart cities is to better empower the real economy and make up for the shortcomings of the physical world. The metaverse has unlimited imagination, and its integration with smart cities has a promising future and will shape new production and life styles as well as a new social form [4-5], and the "metaverse" provides a new path for the ultimate realization of smart cities.

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Exploring enterprises competition: From a perspective of massive recruitment texts mining

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ABSTRACT

Extant research has made limited efforts to conduct competitive intelligence analysis based on recruitment texts. To fill the gap, this study proposes a method for deriving and analyzing competitive relationships, identifying competition paths, and calculating asymmetric competitiveness degrees, from the recruitment texts on e-recruiting websites. Specifically, this study developed a competitive evaluation index system for companies' skill needs and resource base based on 53,171 job descriptions and 42,641 company profiles published by companies across 8 industries (including 35 industry segments) using automated text processing methods. Furthermore, in order to identify competitive paths and calculate the degree of asymmetric competitiveness, this study proposes a modified bipartite graph approach (i.e., MBGA) for competitive intelligence analysis of recruitment texts based on the competition evaluation index system. Experiments on a real-world dataset of the representative companies clearly validated the effectiveness of the method. Compared to the five state-of-the-art methods, MBGA performs better in disclosing the overall competition and is more accurate in terms of the error rating ratio (i.e., ERR) of the competition.

Keywords: Recruitment texts, competitive intelligence, asymmetric competitiveness degrees, bipartite graph.

INTRODUCTION

As the number of enterprise registrations continues to grow and the boundary of industries becomes increasingly blurred, the enterprises and even cross-industry competition have become intense and diverse. With the emergence of new technologies and the development of resources endowment, the overlap in skills demand and resource supply among enterprises has become ubiquitous, as well as competitors are everywhere. In order to adapt to the change market, enterprises must quickly and accurately find rivals, and then clear competitive strategy, own competitive (dis)advantages and specific competitive means (Jantunen *et al.*, 2005).

With the development of Internet, enterprises not only have a broader gathering place, but also leave many traces and information. Also, there is some information with competitive analysis attributes, for example, products and performance information, user search logs and online reviews (Netzer *et al.*, 2012; Ringel & Skiera, 2016; Wei *et al.*, 2016). Based on market commonality of skills demand and resource similarity of resources supply, job descriptions and enterprise profiles contained in recruitment texts can reflect enterprises competition. However, it is obviously not possible to deal with massive recruitment texts manually. Thus, the intelligent text processing method is needed to competitive intelligent analysis between enterprises. Additionally, based on market commonality and resource similarity theories, this study proposes the skills demand for talents market and resources supply about enterprises endowment also have the competitive analysis attributes, which has not been adequately explored in competitive intelligence field.

Based on the above background and extant studies, the following problems still need to be solved. First, how to use intelligent methods to mine competitive information in massive recruitment texts? Second, how to use the competitive information mined above to analyze enterprises competition? In order to solve these problems, this paper uses massive recruitment texts published by enterprises to extract skills demand and resources supply indicators by using text processing methods of Word2Vec and K-means. Then, this paper uses the above indicators and bipartite graph method to visualize competition relations, identify competition paths, and calculate asymmetric competitiveness degrees. Finally, we use enterprises real data to test the effectiveness and advantages of above methods, as well as put forward support for competition strategy.

LITERATURE REVIEW

Research on Enterprises Competition

The research on enterprises competition can be divided into two categories, one is to identify and analyze enterprises competition from marketing and management perspective (Long *et al.*, 2010), the other is from data mining perspective, which proposes how to mine competition information from big data (Gutt *et al.*, 2019; Zhong *et al.*, 2018). This research belongs to the latter, which is to find implicit competition information and knowledge through massive recruitment texts mining, and then to provide support for competition decision. Accordingly, this part review includes competition analysis theories and methods.

The competition analysis theories involve three aspects: market demand commonality or overlapping (Xu *et al.*, 2018), resources supply similarity (Barney, 1991), and integration of demand and supply (Ma, 2015). This study belongs to integration theory perspective. Specifically, this study combines market commonality of skills demand and resource similarity of resources supply. Chen (1996) put forward the theories of market commonality and resource similarity in enterprises competition. The market commonality can be defined as the degree of overlap between enterprises in market, and the definition is mostly based on products or consumers (Chen, 1996). In addition, market is a complex and multidimensional construct that can be adapted to different strategic purposes (Porac & Thomas, 1990). Accordingly, the overlaps demand of talents or skills market also form competition relations. Resource similarity can be defined as types and quantities comparison of strategic resource endowments between enterprises, or the degree of competitors' resource endowments that can compete with focus enterprises (Deng *et al.*, 2017). Enterprises with similar resources may compete for similar strategic capabilities (Chen, 1996). Besides, asymmetric competition is also the focus of this study, that is, threat and competitiveness degree of A to B may be different from B to A (Ringel & Skiera, 2016). In other words, an enterprise can be exclusive in some way, and it cannot be easily replaced by other. This can be interpreted as: there is another exactly the same enterprise, and the exclusivity of focus enterprise is indicated by competitiveness degree between these two identical enterprises. The specific concepts and definitions are shown in Table 1.

Table 1: Definitions of relevant concepts.

Concepts	Author(s) (Year)	Definition / Description
Market Commonality	Chen (1996)	"The degree of presence that a competitor manifests in the markets it overlaps with the focal firm."
Resource Similarity	Chen (1996)	"The extent to which a given competitor possesses strategic endowments comparable, in terms of both type and amount, to those of the focal firm."
Asymmetric Competition	Ringel and Skiera (2016)	"Competitive asymmetry exists when the degree of competition between two firms is not equal, as when Firm A competes more intensely with Firm B than Firm B competes with Firm A."

The competition analysis methods can be divided into relatively traditional and intelligent methods. The former is more focused on theory construction and model building (Peng & Liang, 2016), while the latter (i.e., competitive intelligence) is more focused on extracting competitive content and focused on method innovation (Ringel & Skiera, 2016). For example, Dai *et al.* (2018) used user coincidence to identify competitors based on consumer behavior data, and proposed a competitor identification method that can adapt to dynamic market. However, this method cannot be used in low frequency consumption scenarios. Pant and Sheng (2015) predicted competition relations based on in-links and out-links of websites. Furthermore, studies identified competition relations by building and measuring network structures (Gupta *et al.*, 2019; Ma *et al.*, 2011).

In summary, the competition analysis theories can be summed up as market commonality and resource similarity. Existing studies are based on one of them, and there are few studies on competition analysis from the integration theory. The competition analysis methods can be divided into traditional and intelligent methods, such as case analysis and text mining. Traditional methods are being challenged by lack of dynamic, and intelligent methods have gradually become competition research focus. Therefore, this research attempts to integrate the two theories, and uses intelligent text processing methods for enterprises competition analysis.

Research on Application of Recruitment Information

Recruitment information is an audience-specific message that usually includes position, job responsibilities, qualifications, and enterprise profile, etc. It not only presents the demand of talents and skills, but also the supply of resources, products, and services. So, human resources demand, talents qualification, technologies application and resources endowment can be got by text mining, and even strategic development information can be found. Moreover, massive recruitment texts can be used for competition analysis. This can be reviewed in two ways, that is, extant application contexts of recruitment information mining and competition analysis attributes of various massive texts. Accordingly, this part review includes application contexts of recruitment information mining and competition analysis attributes of different massive texts.

It has become research direction of many scholars to mine recruitment texts, and then to discover potential knowledge as well as to apply it in different contexts. For example, by mining recruitment information, it can identify multifaceted nature of job skills (Gardiner *et al.*, 2018), derive job trends (Smith & Ali, 2014), and adopt association rules to predict industry (Zhang *et al.*, 2017), and so on.

In addition, some studies explored competition analysis attributes of different data (Mohammed *et al.*, 2014). For example, Wei *et al.* (2016) used same functional requirements of different brands in query logs to measure competitiveness degree among enterprises and brands. Qiao *et al.* (2017) mined keywords relationship from user query logs, and then identified competitive keywords to help enterprises make advertising competitive strategy in search engine.

In summary, studies on recruitment information application and competition analysis attributes are shown in Table 2. The former provides a text processing basis for this research. However, there is a lack of semantic understanding in the text processing methods. Additionally, the research of competition analysis attributes about massive texts provides a logical basis for this study. The recruitment information is the same as other kinds of information used for competition analysis, and has competition analysis attributes. However, most of the mentioned above studies focus on jobs, skills analysis, and not explore enterprise level relations. Therefore, this research attempts to mine and apply recruitment texts to analyze enterprises competition.

Table 2: Studies on recruitment information application and competition analysis attributes.

Author(s) (Year)	Application of Recruitment Mining	Contexts of Information	Author(s) (Year)	Competition Attributes of Different Texts	Analysis of Massive Texts
Smith and Ali (2014)	Job trends		Netzer <i>et al.</i> (2012)	UGC	
Zhang <i>et al.</i> , (2017)	Industries association predict		Chakraborti and Dey (2014)	Multi-document Text	
Gardiner <i>et al.</i> (2018)	Multifaceted nature of skills		Ringel and Skiera (2016)	Query logs	
Turrell <i>et al.</i> (2019)	Jobs classification		Nam <i>et al.</i> (2017)	Social tags	
Wu <i>et al.</i> (2019)	State of enterprises aggregation		Gao <i>et al.</i> (2018)	Online reviews	

RESEARCH METHODOLOGY

This study aims to analyze competitive intelligence through recruitment texts mining with utilization of several methods together. The research logic used for this study is illustrated in Figure 1. First, we performed text mining methods using Word2Vec and K-means which is widely applied in the existing text similarity studies. Competitive content was extracted from job descriptions and company profiles, and the evaluation index systems of skills demand and resource base were constructed. Furthermore, we applied a modified bipartite diagram approach to create a bipartite diagram of firm-skills and firm-resources based on the indicators in the indicator system. Then, competitive paths of skills and resources among companies are identified. Based on the competitive path and competitive intensity, the asymmetric competitive degrees between firms are calculated and the asymmetric competitiveness degrees matrix is obtained.

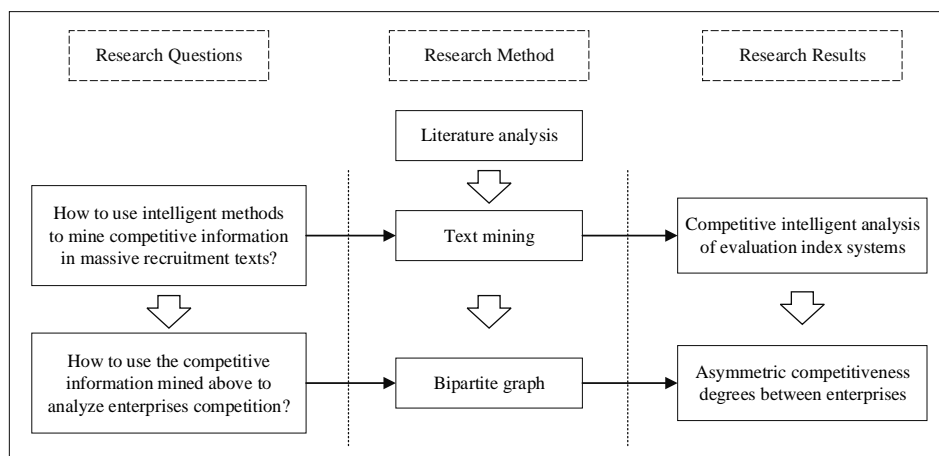


Figure 1: The logic framework of this research.

Data Source

This study used a crawler written in python to collect 53,171 job descriptions and 42,641 company profiles from a well-known recruitment platform called Zhaopin.com from December 2018 to January 2022. The descriptive statistics of companies are shown in Table 3. Founded in 1994, Zhaopin.com has evolved into the leading career development platform in China, providing relevant career and development opportunities for users throughout their careers. The crawling web information is shown in Figure 2. The original texts of "Job Description" and "Company Profile" are in Chinese and have been translated into English as shown in Figure 2.

Table 3: Descriptive statistics of companies.

Category	Subdivision	No.	Accumulative No.	Accumulative %
Industry	IT	6,887	6,887	16.15
	Finance	2,223	9,110	21.36

	Real estate and construction, manufacturing	13,480	22,590	52.98
	Retailing and logistics	2,412	25,002	58.63
	Education media and advertising	5,817	30,819	72.28
	Services	5,875	36,694	86.05
	Marketing and sales	2,806	39,500	92.63
	Personnel administration	1,285	40,785	95.65
	Others (e.g., farming, forestry, husbandry and fishing, etc.)	1,856	42,641	100
Type	Private	28,145	28,145	66.00
	Joint venture	4,753	32,898	77.15
	State-owned	2,286	35,184	82.51
	The listed	1,985	37,169	87.17
	Joint	1,504	38,673	90.69
	Foreign-invested	1,034	39,707	93.12
	Others (e.g., School, Hospital, Bank, etc.)	2,934	42,641	100
Established	2012-2021	9,241	9,241	21.67
	2002-2011	8,428	17,669	41.44
	1992-2001	4,583	22,252	52.18
	1982-1991	1,047	23,299	54.64
	Others (e.g., other years, and not shown)	19,342	42,641	100
Employees	≥ 10000	1840	1840	4.32
	1000-9999	4701	6541	15.34
	500-999	3645	10186	23.89
	100-499	13,207	23,393	54.86
	≤ 99	18,100	41,493	97.31
	Not shown	1,148	42,641	100
Jobs	≤ 5	12,248	12,248	28.72
	6-10	26,970	39,218	91.97
	11-20	868	40,086	94.01
	21-50	859	40,945	96.02
	≥ 51	1696	42,641	100

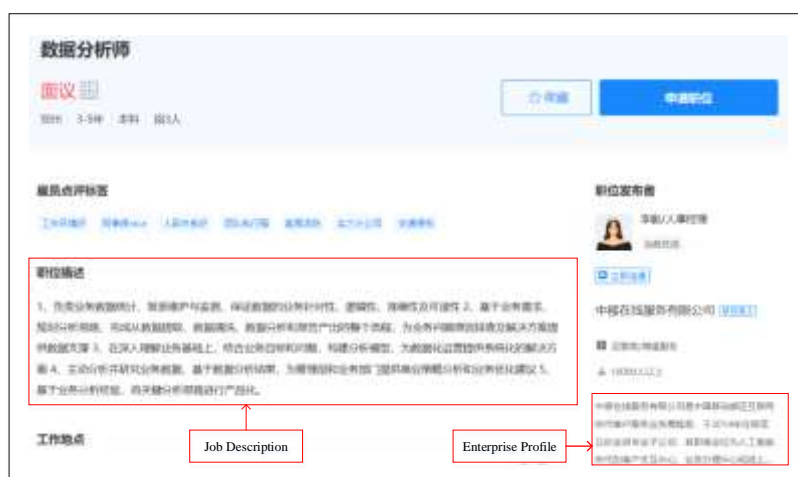


Figure 2: Example of crawling web information.

Text Processing

The purpose of this part is to preprocess and cluster the above recruitment texts. First, Jieba (i.e., Chinese text segmentation tool) with industries lexicons is used to clean data. Specifically, 58 professional industries lexicons about Internet, finance, real estate, trade, retail, education, media, advertising, logistics, marketing, personnel and administration, and so on, from Sogou dictionary, which is often used to improve text segmentation effect (Yan & Ma, 2019), were obtained (An *et al.*, 2019). Next, text mining methods are used to make a meaningful division of above words. It is divided into three steps: (1) using Word2Vec to train word vectors; (2) using K-means to calculate distance between the vectors to divide the words; (3) getting cluster results of skills and resources. The method framework of competitive information mining is shown in Figure 3.

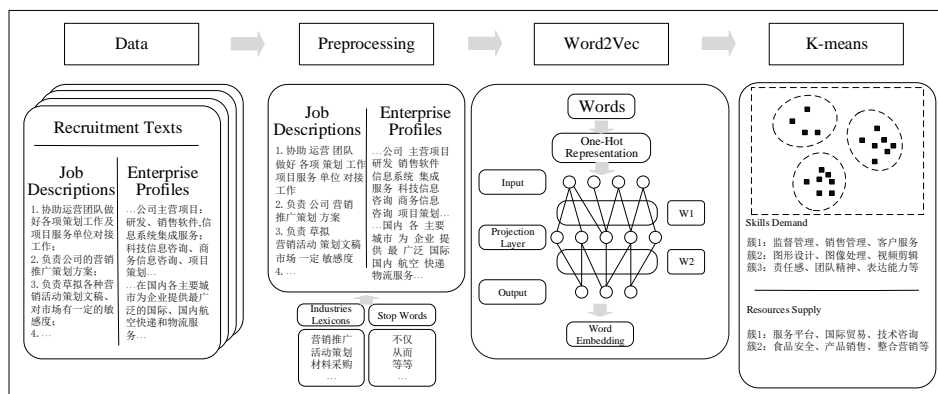


Figure 3: Methods framework of competitive information mining.

CONTENTS AND RESULTS

This part mainly includes three aspects: (1) constructing the competition evaluation index systems of skills and resources; (2) using the index systems combined with bipartite graph to visualize competition relations, identify competitive paths, and calculate asymmetric competitiveness degree between enterprises; (3) using enterprises real data to test validity and advantages of above method, and to provide support for enterprise competition strategy and evaluation.

Construction of Competition Evaluation Index Systems about Skills and Resources

The purpose of this part is to construct competition evaluation index systems of skills demand and resources supply based on cluster results of the above text processing.

Competition evaluation index system of skills demand

To further demonstrate cluster results, this study constructs an index system according to industry classification of zhaopin.com. It is divided into IT, finance, real estate and construction, retail and logistics, education media and advertising, services, marketing and sales, personnel administration. In addition, the industry classification of the platform is instructive, scientific and representative, and the industry classification of other platforms is similar to it. Then, cluster results are mapped to technical/core skills, business/auxiliary skills, and quality/comprehensive skills indicators to show focus and generalization of different skills, and to increase intuitiveness and practicality. The examples of representative indicators of skills demand index system are shown in Table 4.

Table 4: Examples of representative indicators of skills demand index system.

Industry	Technical/Core Skills	Business/Auxiliary Skills	Quality/Comprehensive Skills
IT	Data Analysis	Security control, machine learning, programming technology, programming language, parallel computing, program development, storage technology, etc.; Baidu bidding, shopping search, keyword search, bidding ranking, media planning, media promotion, brand planning, brand marketing, etc.;	security awareness, reasonable suggestion, technical support, information feedback, strict implementation, remedial measures,
	New Media Operation		
Finance	Financial Research	Financial investment, risk management, financial statements, accounting calculation, stock trading, equity investment, property management, etc.;	honest, dependable, trustworthy, take risks, abstract thinking, innovation ability, independent thinking,
	Investment Analysis		
Real Estate and Construction	Architectural Design	Quality control, urban planning, engineering design, process inspection, architectural planning, architectural energy conservation, architectural evaluation, etc.;	dedication, communication, mutual assistance, cooperation, active participation,
	Real Estate Planning		
Retail and Logistics	PM	Material procurement, warehouse receipt, regional agent, price comparison, capital input, capital support, inventory reduction, etc.;	lucubration, quick reaction, logical thinking, collaboration,
	Logistics Operations		
Education Media and	Post Production	Advertising design, advertising agency, technical consultation, content analysis, content production, image processing, graphic	fighting spirit, responsible, adaptability, good attitude,

Advertising	Visual Design	processing, image design, etc.; Glass-fronted billboard recommendation, activity promotion, structure design, interface design, landscape design, space design, art design, etc.;	team spirit, strategic thinking, self-management, rigorousness, etc.
Services	Travel Advice	Consulting service, regional analysis, market information, multidimensional analysis, service consultation, improvement service, customer service, etc.;	
	Hotel Management	Industry analysis, resource management, organization setup, decision analysis, decision support system, sustainable development, practicability analysis, etc.;	
Marketing and Sales	Marketing	Procurement planning, product development, market research, market promotion, pricing strategy, pricing model, advertising planning, etc.;	
	Internet Marketing	Viral marketing, interactive marketing, campaign promotion, WOM marketing, social marketing, online sales, etc.;	
Personnel Administration	HRM	Performance appraisal, performance evaluation, performance assessment, skills training, performance measurement, personnel evaluation, recruitment, etc.;	
	Legal Consultation	Mergers and acquisitions, property security, legal services, annual plans, tax policies, information research, online consulting, strategic planning, etc.	

Tips: PM means Procurement Management; HRM means Human Resources Management.

Competition evaluation index system of resources supply

According to resources endowment and resources utilization capacity in Resource-Based View, this paper demonstrates cluster results. According to characteristics of enterprise resources: value, rareness, imperfect imitability and substitutability (Barney, 1991), and viewpoint that resources are input of production process and capability is efficiency of resources utilization, this study designs initial classification criteria of indicators. According to viewpoint that only by integrating resources purposefully can resources become the source of competitive advantage, and extant core competence of enterprises, namely business environment, enterprise, subject, technology, product and core product subsystem (Wang *et al.*, 2000), the study designs ultimate classification criteria of indicators. The examples of representative indicators of resources supply index system are shown in Table 5.

Table 5: Examples of representative indicators of resources supply index system.

Resources Endowment	Indicators	Enterprise Capacities	Indicators
Technology Resources	Office automation, financial management, test center, product inspection, product design, project contracting, program development, financial accounting, financial consulting, color printing and packaging, multimedia technology, molecular biology, structural design, molding technology, software testing, business intelligence, QIC, MES, professional translation, integrated marketing, information security, identification system, biological prevention and control, digital technology, hydraulic engineering, network resources, etc.;	Resource Utilization Capacities	Exclusive agency, sole proprietorship, leading position, domain expert, leading enterprise, authoritative authentication, national top ten, the listed company, provincial key, world leading, global strategy, international finance, state-owned bank, state-owned capital, joint ventures/enterprises, leading brands, authoritative departments, authoritative institutions, trinity/three-in-one, joint ventures, foreign sole ownership, Chinese-western combination, directly affiliated department, environment friendly, industry pilot, five-in-one, pillar industries, well-known brands, well-known trademarks, general distributors, well-known enterprises, etc.;
Natural Endowments	Red/Revolutionary tourism, mineral resources, national characteristics, beautiful scenery, ecological landscape, scarce resources, renewable energy, renewable resources, Chinese culture, sightseeing agriculture, central location, etc.;		Safety equipment, safety glass, packaging materials, glass fiber, heating system, TCFL, synthetic rubber, care products, integrated circuits, hotel supplies, adhesive products, air conditioning equipment, access control systems, automotive parts, green building materials, semiconductor device, insulation materials, glass curtain wall,
Industry Positioning	Health food, insurance industry, tutorial school, editing and publishing, hotel, financial consulting, catering industry, coal industry, food industry, municipal engineering, film and television production, examination-oriented education, housing industry, online education, early education, information industry, medical cosmetology, pharmaceutical industry, preschool, garden engineering, legal consulting, higher education,	Core Products	

	outdoor products, household products, etc.;		financial software, diesel engines, electrical equipment, elevator accessories, protective supplies, non-metallic materials, clothing, composite materials, mobile phone accessories, etc.
Market Area	Large and medium cities, large, medium and small cities, three northeast provinces, Southeast Asia, whole country, Shenzhen sez, Hong Kong and Macao regions, Hong Kong, Macao and Taiwan regions, Guangdong region, Chengdu Region, Europe and America region, Zhangjiajie, Pearl River Delta region, Tibet region, etc.;		

Tips: QIC means Quality Inspection Center; MES means Manufacturing Execution System; TCFL means Teaching Chinese as Foreign Language.

Competition Analysis between Enterprises Based on Bipartite Graph

The purpose of this part is to visualize competition relations, identify competitive paths, and then to quantify asymmetric competitiveness degrees between enterprises, using indicators of skills demand and resources supply in the above index system, as well as bipartite graph.

Bipartite graph method has been widely used in relation recognition between entities (Choi *et al.*, 2022; Liu *et al.*, 2020; Wei *et al.*, 2016). Inspired by Wei *et al.* (2016) research logic, this research following the logic expands and verifies bipartite graph method in competitive intelligence field. In addition, this research made the following improvements to the method: First, this study uses multisource texts (i.e., job descriptions and enterprise profiles from recruitment texts) based on market commonality and resource similarity theories, to verify the validity of the method. Second, this study adjusts the competition paths identification and asymmetric competitiveness degrees calculation based on the multisource texts, to expand the applicability of the method.

Bipartite graphs construction of competition relations

This study uses bipartite graph to analyze competition, that is, visualize competition relations between enterprises in skills demand and resources supply. Firstly, two bipartite graphs of enterprises-skills and enterprises-resources are constructed by using nodes with different attributes and edges between the nodes. Then, based on the above bipartite graphs and the evaluation index systems, the frequency, which represents enterprise's demand for the skill or supply for the resource mined from job descriptions and enterprise profiles respectively, of each edge can be indicated. It can be defined as follows:

Definition 1: Given three sets of entities $E = \{e_1, e_2, e_3, \dots\}$, $S = \{s_1, s_2, s_3, \dots\}$, and $R = \{r_1, r_2, r_3, \dots\}$ respectively representing enterprises, skills and resources, the entities with different attributes can be connected by L_{ES} and L_{ER} , and then bipartite graphs of enterprises-skills $B_s = \{E, S, L_{ES}\}$ and enterprises-resources $B_r = \{E, R, L_{ER}\}$ can be build.

Where E is enterprises set, S is skills demand set corresponding job descriptions, and R is resources supply set corresponding enterprise profiles. L_{ES} is a set of edges, defined by the focus enterprise corresponding skills demand and frequency, and L_{ER} defined by the focus enterprise corresponding resources supply and frequency. Structurally, E , S , and R represent three nodes set, i.e. enterprises, skills, and resources, as well as L_{ES} and L_{ER} represent two edges set, i.e. E and S or E and R . Next, this research uses above definition and overall enterprises information mined from job descriptions and enterprise profiles, as shown in Table 6, to construct enterprises- skills and enterprises-resources bipartite graphs, as shown in Figure 4.

Table 6: Bipartite graphs construct information (an illustrative example).

Enterprises	Skills Demand	Frequency	Resources Supply	Frequency
e_1	Product marketing	12	Information system	9
	Data analysis	10	Clients database	8
	Website OM	9	Marketing tactics	8
e_2	Product marketing	15	Information system	9
	Video editing	11	Marketing tactics	12
	Website OM	10	Patent technology	11
e_3	Data analysis	13	Clients database	11
	Video editing	12	Patent technology	13
	Webpage production	15	International trade	10

Tips: Website OM means Website operation and maintenance.

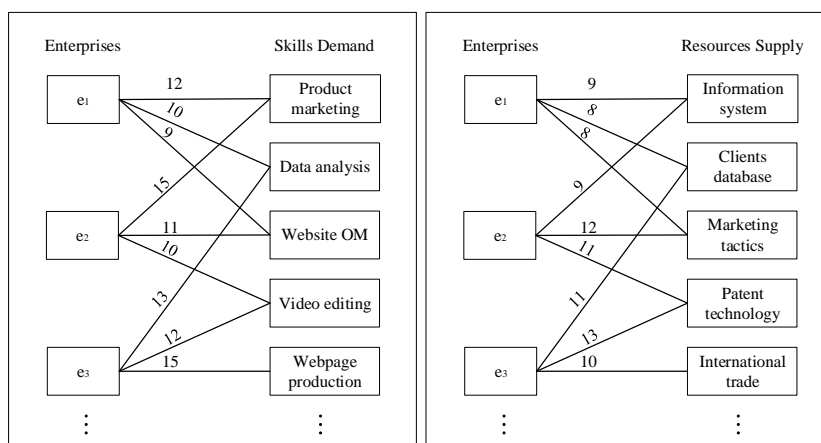


Figure 4: Bipartite graphs of skills demand and resources supply (an illustrative example).

Competition paths identification based on the above bipartite graphs

In order to measure asymmetric competitiveness degrees between enterprises, after constructing the bipartite graphs, we must identify competition paths, i.e., overlap in which skills are demanded or resources are supplied, between paired enterprises. In other words, connecting two enterprises with the same skills demand or resources supply, it can be defined as follows:

Definition 2: Given $B_s = \{E, S, L_{ES}\}$ and $B_r = \{E, R, L_{ER}\}$, for $e_x, e_y \in E$, there are $s_i \in S, r_j \in R, l_{xi} \in L_{ES}, l_{yi} \in L_{ES}, l_{sj} \in L_{ER}$, and $l_{rj} \in L_{ER}$, and then competition paths can be defined as $Compath(e_x \rightarrow s_i \rightarrow e_y)$ and $Compath(e_x \rightarrow r_j \rightarrow e_y)$. Obviously, if the above paths exist, there are competition paths $Compath(e_y \rightarrow s_i \rightarrow e_x)$ and $Compath(e_y \rightarrow r_j \rightarrow e_x)$.

This study uses above definition and constructed bipartite graphs to identify competition paths between paired enterprises, as shown in Table 7.

Table 7: Competition paths identification between enterprises (an illustrative example).

Competition paths of skills demand	Example	Competition paths of resources supply	Example
$e_1 \rightarrow s_i \rightarrow e_2$	$e_1 \rightarrow Product\ marketing \rightarrow e_2$ $e_1 \rightarrow Website\ OM \rightarrow e_2$	$e_1 \rightarrow r_j \rightarrow e_2$	$e_1 \rightarrow Information\ system \rightarrow e_2$ $e_1 \rightarrow Marketing\ tactics \rightarrow e_2$
$e_1 \rightarrow s_i \rightarrow e_3$	$e_1 \rightarrow Data\ analysis \rightarrow e_3$	$e_1 \rightarrow r_j \rightarrow e_3$	$e_1 \rightarrow Clients\ database \rightarrow e_3$
$e_2 \rightarrow s_i \rightarrow e_3$	$e_2 \rightarrow Video\ editing \rightarrow e_3$	$e_2 \rightarrow r_j \rightarrow e_3$	$e_2 \rightarrow Patent\ technology \rightarrow e_3$

Asymmetric competitiveness degrees calculation based on the above competition paths

Competitiveness degree is a relative measure of dynamic competition in a particular market environment, defined by a given enterprises set. Once an enterprises set is defined, competitiveness degree of every paired enterprise can be calculated (Wei et al., 2016). Therefore, competitiveness degree is a kind of reflect and measure to competitive degree, and the two concepts are not distinguished in this study. To calculate asymmetric competitiveness degrees, the first step is to determine intensity of skills demand or resources supply for the enterprises included in the competition paths, which can be defined as follows:

Definition 3: Given $l_{xi} \in L_{ES}$ and $l_{yj} \in L_{ER}$, the e_x ' demand for s_i can be defined as $|e_x s_i|$, and supply for r_j can be defined as $|e_x r_j|$. For s_i and r_j , the probability of co-occurrence with e_x can be defined as $p(e_x \rightarrow s_i) = |e_x s_i| / |e_x|$ and $p(e_x \rightarrow r_j) = |e_x r_j| / |e_x|$.

For e_x , the probability of co-occurrence with s_i and r_j can be defined as $p(s_i \rightarrow e_x) = |s_i e_x| / |s_i|$ and $p(r_j \rightarrow e_x) = |r_j e_x| / |r_j|$.

Where $|e_x s_i|$ and $|e_x r_j|$ reflect intensity of skills and resources. $|e_x|$ is intensity sum of skills demanded for or resources supplied to e_x compete with other enterprises. In skills demand, $|e_x|$ reflects the extent to which e_x considers s_i as an important skill for itself. This is identification of specific skill from skills pool owned by the focus enterprise, in turn this reflects enterprise' demand intensity for that skill. Similarly, in resources supply, $|e_x|$ can reflect the extent to which e_x considers r_j as an important resource for its own. This is identification of specific resource from resources pool owned by the focus enterprise, in turn this reflects enterprise' supply intensity for that resource. $|s_i|$ is demand intensity sum of all enterprises for this skill, and reflects the extent to which e_x considers s_i may be needed by itself, that is, the probability of s_i being demanded as one of many skills. This is identification of specific enterprise from enterprises pool that demands the skill, and reflects demand

intensity for that skill. Similarly, $|r_j|$ is supply intensity sum of all enterprises for this resource, and reflects the extent to which e_x considers r_j to be own resource capability, that is, the probability of S_i being possessed as one of many resources. This is identification of specific enterprise from enterprises pool that supplies the resource, and reflects supply intensity for that resource. See Table 8 for details.

Table 8: Skills demand or resources supply intensity (an illustrative example).

Skills Demand Intensity $ e_x S_i $	Overall Skills Demand Intensity $ e_x $	Resources Supply Intensity $ e_x r_j $	Overall Resources Supply Intensity $ e_x $	
$ e_1 \text{Product marketing} =12$ $ e_1 \text{Data analysis} =10$ $ e_1 \text{Website OM} =9$	$ e_1 =12+10+9=31$	$ e_1 \text{Information system} =9$ $ e_1 \text{Clients database} =8$ $ e_1 \text{Marketing tactics} =8$	$ e_1 =9+8+8=25$	
$ e_2 \text{Product marketing} =15$ $ e_2 \text{Website OM} =11$ $ e_2 \text{Video editing} =10$		$ e_2 \text{Information system} =9$ $ e_2 \text{Marketing tactics} =12$ $ e_2 \text{Patent technology} =11$		$ e_2 =9+12+11=32$
$ e_3 \text{Data analysis} =13$ $ e_3 \text{Video editing} =12$		$ e_3 \text{Clients database} =11$ $ e_3 \text{Patent technology} =13$		
	$ S_i $	$ r_j $		
	$ \text{Product marketing} =12+15=27$ $ \text{Data analysis} =10+13=23$ $ \text{Website OM} =9+11=20$ $ \text{Video editing} =10+12=22$	$ \text{Information system} =9+9=18$ $ \text{Clients database} =8+11=19$ $ \text{Marketing tactics} =8+12=20$ $ \text{Patent technology} =11+13=24$		

Next, to calculate asymmetric competitiveness degrees for a particular skill demand between paired enterprises, it can be defined as follows:

Definition 4: For e_x and e_y , according to $Compath(e_x \rightarrow s_i \rightarrow e_y)$ and $Compath(e_x \rightarrow r_j \rightarrow e_y)$, the competitiveness degree between enterprises in S_i and r_j can be defined as $Comps_i(e_x, e_y) = p(e_x \rightarrow s_i) \times p(s_i \rightarrow e_y)$, $Comps_i(e_y, e_x) = p(e_y \rightarrow s_i) \times p(s_i \rightarrow e_x)$, and $Compr_j(e_x, e_y) = p(e_x \rightarrow r_j) \times p(r_j \rightarrow e_y)$, $Compr_j(e_y, e_x) = p(e_y \rightarrow r_j) \times p(r_j \rightarrow e_x)$.

Definition 3 and 4 involve overall skills or resources of different enterprises. This reflects range and extent to which different enterprises' skills demand or resources supply. For example, if enterprise focuses on a small number of skills or resources, it will be more competitive in a particular skill or resource. On the other hand, enterprise focuses on a lot of skills or resources, then it will be less competitive in a certain skill or resource. Then, the asymmetric competitiveness degrees between enterprises can be observed, and are very common in real world. When $|e_x|$ and $|e_y|$ is equal, the competitiveness degrees are theoretically equal, which is virtually non-existent. Finally, the overall asymmetric competitiveness degrees of paired enterprises can be calculated as follows:

Definition 5: For e_x and e_y , the overall asymmetric competitiveness degree can be defined as $Comp(e_x, e_y) = \frac{1}{2} \sum_{s_i \in S} Comps_i(e_x, e_y) + \frac{1}{2} \sum_{r_j \in R} Compr_j(e_x, e_y)$, which has a range of [0,1], and $e_y \in E$. Similarity, the asymmetric competitiveness degree is $Comp(e_y, e_x) = \frac{1}{2} \sum_{s_i \in S} Comps_i(e_y, e_x) + \frac{1}{2} \sum_{r_j \in R} Compr_j(e_y, e_x)$.

This definition reflects overall asymmetric competitiveness degrees of enterprises in multiple competition paths. For e_x , in skills demand and resources supply, the overall asymmetric competitiveness degrees of focus enterprise with all other enterprises in enterprises set is 1, which can be proved mathematically. This also describes an actual context: for a given enterprises set, the scope of competition analysis is defined as each enterprise in the set.

Based on the above definition and demand or supply intensity, this study calculates skills and resources asymmetric competitiveness degrees of paired enterprises, and then gets overall asymmetric competitiveness degrees, as shown in Table 9.

Table 9: The asymmetric competitiveness degrees between enterprises (an illustrative example).

Competitiveness Degree of Skills Demand between Enterprises	Competitiveness Degree of Resources Supply between Enterprises			Overall Competitiveness Degree between Enterprises						
Enterprises	e_1	e_2	e_3	e_1	e_2	e_3	Enterprises	e_1	e_2	e_3

e_1	0.4429	0.3747	0.1823	0.4427	0.3720	0.1853	e_1	0.4428	0.3734	0.1838
e_2	0.3227	0.5258	0.1515	0.2906	0.5232	0.1862	e_2	0.3067	0.5245	0.1689
e_3	0.2261	0.2182	0.5557	0.1930	0.2483	0.5588	e_3	0.2095	0.2332	0.5572

Experiment of the above Competition Analysis Method

This part uses real enterprise recruitment texts and above methods to analyze competition. And, this is to verify validity and advantages of the above method, as well as provide support for enterprise competition strategy and evaluation based on the results.

Competition analysis experiment

Details of the 10 representative enterprises are shown in Table 10. They are the 10 enterprises with the highest number of recruitment texts in IT and finance industry respectively during data collection period. At present, these two industries not only have a large increase in talents demand (Hu *et al.*, 2019), but also have a cross-industry combination in technologies and functions (Du *et al.*, 2019). The competition analysis between them can check the method validity, examine inter- and exter-industry competition, as well as calculate asymmetric competitiveness degrees between enterprises. The algorithm of competition analysis is shown in Table 11, and the asymmetric competitiveness degrees matrix is shown in Table 12.

Table 10: Descriptive information of ten enterprises.

No	Industry	Recruitment Information Quantity	Size	Nature	Samples of Recruitment Position
1	IT/EC	293	500-1000	JVE	Foreign exchange trader, financial data analysts
2	IT/EC	288	500-1000	JVE	Customer servicer, office clerk
3	Finance/Investment	283	500-1000	PE	Financial data analysts, foreign exchange trader
4	IT/EC	255	500-1000	JVE	EC operation specialist, data analysis specialist
5	Finance/Investment	226	100-500	JVE	Financial transactions specialist, data analysis specialist
6	Finance/Investment	191	100-500	JVE	Financial transactions specialist, financial analysts
7	IT/EC	183	500-1000	FIE	Data analyst, foreign exchange trader
8	IT/EC	181	500-1000	FIE	Data analysis specialist, PA specialist
9	Finance/Investment	180	100-500	PE	Financial analysts, data analyst
10	Finance/Investment	177	50-150	PE	Foreign exchange trader, financial transactions specialist

Tips: EC means electronic commerce; JVE means joint venture enterprise; PE means private enterprise; FIE means foreign-invested enterprise; PA means performance appraisal.

Table 11: The algorithm of competition analysis.

Algorithm: Competition analysis process between companies

```

Input: Company entities set  $E$ , job descriptions  $E\_JD$ , company profiles  $E\_EP$ , skills demand indicators  $S$ , resource base indicators  $R$ 
for each  $e$  in  $E$  do
for each  $e\_jd$  in  $E\_JD$  do
# Extracting skills demand indicators  $e\_s_i$ 
if  $e\_s_i \in S$  then
 $e\_s_i = e\_s_i + 1$ 
end if
end for
# " for each  $e\_ep$  in  $E\_EP$  do " and "Extracting resource base indicators  $e\_r_j$  ", same as above
end for
 $E\_S = \{e \in E | e\_s\}$ ,  $E\_R = \{e \in E | e\_r\}$  # Constructing companies-skills and companies-resources bipartite graphs
for each  $e_x$  in  $E$  do
for each  $e_y$  in  $E$  do
if  $\exists s_i \in (e_x\_s \cap e_y\_s)$  then
 $Comps(e_x, e_y) = skills\_demand(e_x, e_y, s_i)$  # Calculating the competitiveness degree of skills demand about  $e_x$  to  $e_y$ 
end if

```

" if $\exists r_j \in (e_x - r \cap e_y - r)$ then" and "Calculating the competitiveness degree of resource base about e_x to e_y ", same as above
 end for
 end for

$$Comp(e_x, e_y) = \frac{1}{2} Comps(e_x, e_y) + \frac{1}{2} Compr(e_x, e_y) \quad \# \text{ Calculating the competitiveness degree about } e_x \text{ to } e_y$$

" for each e_y in E do" and "Calculating the competitiveness degree about e_y to e_x ", same as above

Output: $Comp(e_x, e_y)$, $Comp(e_y, e_x)$ # Obtaining the asymmetric competitiveness degrees matrix between paired companies

Table 12: The asymmetric competitiveness degrees matrix between enterprises.

E	e_1	e_2	e_3	e_4	e_5	e_6	e_7	e_8	e_9	e_{10}
e_1	0.2266	0.0330	0.2189	0.0218	0.1060	0.1178	0.0552	0.0557	0.1159	0.0491
e_2	0.0132	0.8650	0.0298	0.0099	0.0101	0.0290	0.0084	0.0149	0.0125	0.0072
e_3	0.1492	0.0617	0.2829	0.0314	0.0757	0.1037	0.0529	0.0735	0.1293	0.0398
e_4	0.0663	0.0297	0.1617	0.3167	0.0738	0.0297	0.0530	0.1426	0.0899	0.0367
e_5	0.1082	0.0165	0.1177	0.0248	0.3869	0.0926	0.0641	0.0209	0.0755	0.0929
e_6	0.0870	0.0536	0.1032	0.0102	0.0588	0.4974	0.0690	0.0256	0.0538	0.0414
e_7	0.1036	0.0154	0.1420	0.0338	0.1243	0.1888	0.2332	0.0502	0.0679	0.0408
e_8	0.0559	0.0170	0.1109	0.0494	0.0159	0.0296	0.0232	0.6096	0.0538	0.0346
e_9	0.1547	0.0378	0.2580	0.0359	0.0971	0.1013	0.0517	0.0719	0.1451	0.0466
e_{10}	0.1075	0.0100	0.0942	0.0170	0.2576	0.1242	0.0435	0.0421	0.0750	0.2288

Content validity of the competition analysis evaluation index systems

In this part, three experts in EC field in two universities were invited to evaluate the index systems, that is, to test content validity of the index systems. Questionnaire design: (1) 50 skill indicators and 50 resource indicators were randomly selected from the index systems. (2) The question "Do you think this indicator(term) is a valid indicator of skills demand (or resources supply) of enterprise?" and the options "Validity, recommended to be retained" and "Not recommended to be retained" were set. Survey process: (1) The paper questionnaire including above 100 skill and resource indicators were provided to three experts, who were given definitions of skills demand and resources supply and understood the meaning of question. If the experts still have questions, researchers continue to answer in-depth. The experts could fill in questionnaire until were no longer in doubt. (2) After three working days, the questionnaire was retrieved. Data processing: Content validity ratio CVR was calculated for each indicator, i.e., $CVR = (Ne - N/2) / (N/2)$. Where, Ne is the number of experts who chose "Validity, recommended to be retained", and N is the total number of experts, as well as value range of CVR is [-1,1]. If CVR is positive, the indicator should be retained, and if negative, should not be retained (Wei & Huang, 2015; Yu & Wen, 2011). The CVR of 100 indicators were all positive, which indicated the indicators selected randomly were all validity.

Results and Visualization

Taking e_1 in the asymmetric competitiveness degrees matrix as an example, the following competition decision analysis can be carried out to provide decision-making recommendations for competition practice. First, according to the asymmetric competitiveness degrees matrix, the asymmetric competition relations between focal company and others can be compared, and then the set of competitors with relative (dis)advantages can be delimited. For example, the focal company has equal competitiveness degrees with e_1 and e_8 , and has advantages when facing e_2 , e_3 , and e_6 , while it has disadvantages when facing e_4 , e_7 , e_9 , and e_{10} . Then, according to the set of competitors, focal company can adopt various competition strategies to consolidate or improve its market share or position in industry. In addition, according to the various competition strategies, and combining with concrete competition paths, focal company can adjust or determine future competition focus. For example, when facing e_3 , the focal company can take active strategies in such fields as financial investment, marketing, data analysis and security control, stock trading, and international financial trade, and so on. When facing e_9 , it can take strategic actions in such areas as online marketing, customer service, and online platform building, and so on, which will consume more resources and last longer. Finally, considering the identified skills or resources focus, focal company can evaluate their monopoly fields in skills or resources and competing solutions. For example, it can integrate and build internal and external capabilities to respond to a rapidly changing environment by proactively perceiving, seizing opportunities, and making adaptive changes (Teece et al., 1997).

In order to enhance the interpretability about the overall competitive situation, the asymmetric competitiveness degrees matrix is taken as input of Social Network Analysis (SNA), and the centralities of each company are calculated. The results are illustrated in Figure 5. Concretely, horizontal and vertical axis respectively represent outdegree and indegree, that is, the competitiveness degree of the focal company to other companies, and other companies to the focal company. In the context of

this study, we, based on different competing entity perspectives, named the outdegree as competitive attack, while named the indegree as competitive threat.

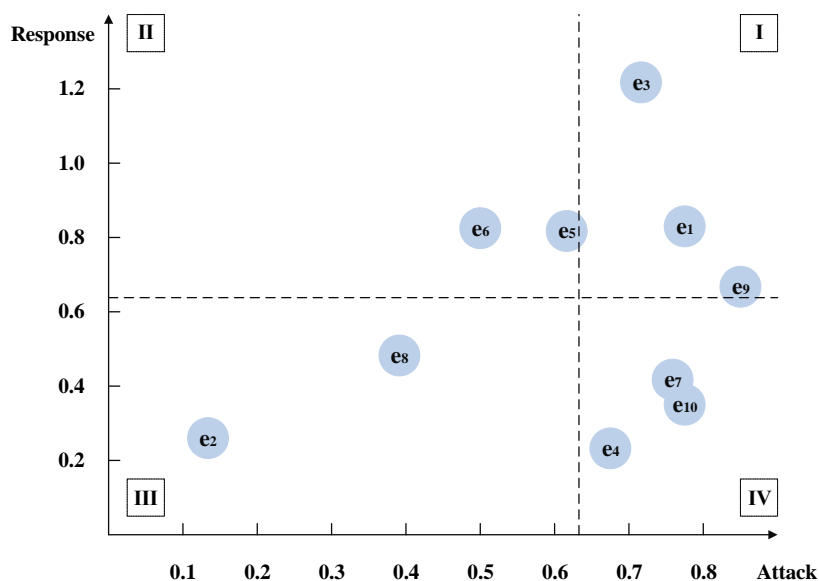


Figure 5: The overall competitive situation based on asymmetric competitiveness degrees.

According to average outdegree and average indegree of companies set, the overall competitive situation can be divided into four quadrants. In quadrant I, both outdegree and indegree are above the average. When companies are faced with fierce competition (e.g., e_1 , and e_3), they are distributed in quadrant I, which means both the threat from the focal company to other companies and the threat from other companies to the focal company are significant. In quadrant II, outdegree is below the average and indegree is above the average. When firms lack a competitive advantage (e.g., e_6), they are distributed in quadrant II, which means that other firms are more of a threat to the focal firm than the focal firm is to other firms. In quadrant III, outdegree and indegree are below the average. When companies are exclusive (i.e., e_2 and e_8), they are usually distributed in quadrant III, which means that the two threats are small. In quadrant IV, outdegree is above the average and indegree is below the average. When firms have a competitive advantage (e.g., e_4), they are distributed in quadrant IV, which means that the focal firm is more of a threat to other firms than other firms are to the focal firm.

Baseline Model Comparison

Given that there is no algorithm proposed for identifying firm competitive relationships from recruitment text data, we compare the results of firm competitive relationship obtained from the analysis of recruitment texts using classical coupling index method and different text classification and matching methods with the approach proposed in this article to validate the advantages of our proposed approach.

The coupling index has been proposed to reflect correlations among subjects. In a given entities set, coupling index is the ratio of the number of shared technologies over the sum of technologies of two paired entities (Lo, 2008). And, few extant studies suggested the coupling index can reflect similarity between subjects (Hong & Li, 2013). Therefore, this study uses coupling index to calculate similarity of skills demand and resource base of the ten companies in the experiment.

By comparing the results of coupling index, we found: (1) the coupling index method only measures the similarity of skills and resources between companies but cannot conduct asymmetric competition analysis; (2) the coupling index method only considers skills and resources set when calculating competitiveness degree, and has some deficiencies in visualization of competition relations, identification of competition paths, and analysis of competition focus. However, competitiveness degree between paired companies is rarely equal, and asymmetric competitiveness degrees are more common.

Second, we also use TF-IDF and BERT methods as baseline, which can be treated as a simplified version of our method. Concretely, the job descriptions and company profiles are represented by using these two methods, and the competitiveness degrees matrix among companies are obtained.

Also, we chose two state-of-the-art text classification and matching methods as the baseline models. One is Long Short-Term Memory (LSTM) network, the other is Convolutional Neural Network (CNN).

The results of the focal company overall competitive situation based on SNA are illustrated in Figure 6. The Figure shows that the modified bipartite graph approach (Modified BGA) can divide the competitors into different sections, which the focal company is at an advantage or a disadvantage or the degrees of mutual competitiveness are equal, by revealing the asymmetric competitiveness degree. For example, facing with e_2 , e_3 , and e_6 , e_1 has a competitive advantage, facing with e_4 , e_7 , e_9 ,

and e_{10} , e_1 has a competitive disadvantage, and facing with e_5 and e_8 , the degree of threat between e_1 and them is equal. However, the other five methods (*i.e.*, Coupling Index, TF-IDF, BERT, LSTM, and CNN) can only get the competitiveness degree of the focal company compared with the average competitiveness degree between focal and all other companies, by revealing the symmetrical competitiveness degree. Take the coupling index method as an example, which is similar to the TF-IDF, BERT, LSTM, and CNN, the competitiveness degrees between e_1 and e_2 , e_4 , e_8 , e_{10} are lower than the average, but the competitiveness degrees between e_1 and e_3 , e_5 , e_6 , e_7 , e_9 are higher than the average. On top of this, the five baseline models are unable to disclose the overall competitive situation.

We use the error-rank ratio (ERR) to quantify the method accuracy. The assessment of competitiveness rank relies on using three experts to evaluate and rate ten companies based on their relevance and representativeness to IT and finance domain. A questionnaire was designed with (1) information of 10 companies; (2) two questions "Please rank the nine companies (*i.e.*, e_2 to e_{10}) based on threat degree of focal company (*i.e.*, e_1) to them" and "Please rank the nine companies (*i.e.*, e_2 to e_{10}) based on threat degree of them to focal company (*i.e.*, e_1)". The ranks of three experts were respectively averaged to obtain two final competitiveness ranks, which represent competitive attack and competitive response of focal company. The ERR of variety

methods was calculated, *i.e.*,
$$ERR = \sqrt{\sum_{j=2}^{10} (Rank_{KE,j} - Rank_{ME,j})^2}$$
, where $Rank_{KE,j}$ is the rank of expert evaluation, and $Rank_{ME,j}$ is the rank of methods (*i.e.*, MBGA, CI, TF-IDF, BERT, LSTM, and CNN). The competitiveness rank and ERR are shown in Table 13. The result indicates the MBGA method not only provides insight into the asymmetric competitiveness degrees, but has the lowest ERR.

CONCLUSION AND DISCUSSION

Online recruitment services offer a viable solution to the difficult situation between employers and job seekers during the 2019 Coronavirus Disease (COVID-19) global pandemic by providing timely and effective job search and hiring information. The rapid growth of online recruitment services has also accumulated a large amount of recruitment text data which contain rich information regarding employers and job seekers. Although the existing studies have proposed a myriad of strategies to study competitor analysis and inter-firm rivalry from different data sources (*e.g.*, site-centric data, in-links and out-links of websites, etc.), limited efforts have been devoted to implementing competitor analysis from recruitment text data. In this article, we proposed a feasible method framework to analyze companies' competitors and asymmetric competitiveness degrees from the massive unstructured recruitment texts. The key idea is to exploit the wealth of information in the job description and company profile in the recruitment text. We first proposed semantic representations for both job descriptions and company profiles and constructed skills demand and resource base competition evaluation indicators from the job descriptions and company profiles. Then, we used the competition evaluation index system and a modified bipartite graph method to display competition relations. Finally, we used the results of bipartite graphs to identify competition paths between paired companies and calculated asymmetric competitiveness degrees. Based on a real-world dataset, we clearly showed the effectiveness and interpretability of the proposed method compared to some baseline models.

This research has two theoretical significances. First, this study contributes to the massive recruitment texts mining literature by enriching method framework of competitive intelligence. The method framework uses Word2Vec to extract competition information of skills demand and resources supply, and uses K-means to construct the evaluation index systems, then gets bipartite graphs of enterprises-skills and enterprises-resources to quantify asymmetric competitiveness degrees. Second, this study contributes to the market and resource competition theories literature by enriching research context of data source used in competition analysis. Based on theories of market commonality and resource similarity, this study finds recruitment texts has competition analysis attributes.



Figure 6: The focal company overall competitive situation based on SNA using variety methods.

Table 13: The competitiveness rank and error-rank ratio (ERR) based on e_1 using variety methods.

Co.	Competitive Attack				Competitive Response									
	EE	MBGA	CI	TF-IDF	BERT	LSTM	CNN	EE	MBGA	CI	TF-IDF	BERT	LSTM	CNN
e_2	2	2	8	8	8	2	4	8	8	8	8	8	2	4
e_3	8	5	2	2	2	8	6	2	2	2	2	2	8	6
e_4	5	8	6	6	4	4	2	6	4	6	6	4	4	2
e_5	4	4	4	5	6	5	5	9	9	4	5	6	5	5
e_6	9	7	5	4	9	1	9	4	6	5	4	9	1	9
e_7	6	6	7	9	5	7	7	5	5	7	9	5	7	7
e_8	7	9	9	7	7	9	8	3	3	9	7	7	9	8
e_9	1	1	1	3	1	6	3	1	7	1	3	1	6	3
e_{10}	3	3	3	1	3	3	1	7	1	3	1	3	3	1
ERRa/r	-	5.10	9.70	10.77	8.83	9.80	5.29	-	8.94	9.06	9.38	8.37	13.49	12.57
Overall	-	14.04	18.75	20.15	17.20	23.29	17.86	-	-	-	-	-	-	-

Notes: Co. (companies); EE (Expert Evaluation); MBGA (Modified Bipartite Graph Approach); CI (Coupling Index); ERRa/r (error-rank ratio of attack or response); Overall (overall error-rank ratio, which is the sum of "Competitive Attack" and "Competitive Response").

This study has three practical implications. First, this study is beneficial to enterprises to rapidly identify competition focus and quantify competitiveness degree through recruitment texts. Quickly extracting competitive knowledge and transforming into decision-making basis can help enterprises to analysis competitors, use appropriate strategies, and play a more influential,

rather than passive or reactive, role in competition. The competitiveness degrees help managers understand how competitors tend to switch skills and resources dynamically, and obtain further insights in analyzing the dynamics of skills demand and resources supply of competitors. Second, this research is beneficial to recruitment platform to grasp enterprises overall development, and then to promote effective matching of talents. By understanding enterprises reality and forming a good interactive environment, the recruitment platform can attract enterprises to register and post positions, and then attract applicants to register and upload resumes, finally improve success rate of talents and enterprises matching. Third, this research is helpful for applicants to grasp enterprises development focus and trends, so as to quickly select out enterprises, which match their own professional skills and career.

This study has some limitations that future research could address. First, we used word2Vec as input feature instead of the Bag-of-Words as input features. A potential limitation of using this approach is that the pre-trained word vectors may not be sufficient to describe the semantic features of the recruitment text data, which can affect the accuracy of the index systems construction for competitive analysis. Future research could attempt to use state-of-the-art deep learning text processing methods for semantic-based analysis, such as the deep graph CNN model and hierarchical attention network to improve the accuracy of the index systems. Besides, the system of competition analysis indicators established in this study covers as many levels and dimensions as possible, but may still exclude the existence of some other valid indicators. Future studies can expand the adaptability based on the indicator system of this study, taking into account the specific situation. Second, in addition to the accuracy of the text semantic algorithm, the quality of the evaluation indicators in this study also depends heavily on the manual inspection of features or key phrases by domain experts. However, manual inspection leads to high costs and inefficient, inaccurate and subjective judgments. Thus, future research is encouraged to develop new approaches to screen indicators without relying on human judgment. Finally, this study mainly focuses on the Chinese recruitment platform texts, and does not involve the non-Chinese recruitment texts. Future research could consider investigating in different linguistic settings and national cultural contexts to discover and deepen the applicability of the study.

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Factors influencing intention to purchase through VR platforms

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ABSTRACT

With technological advancement, Virtual Reality (VR) significantly impacts various industrial sectors, including education, medicine, gaming, and tourism. In particular, the idea of VR has been extensively applied in e-commerce to create realistic online shopping experiences. The purpose of this study is to investigate factors influencing purchase intention through VR platforms by applying the concept of the IS success model and flow theory. The data were collected from 300 respondents with experience in online shopping via e-commerce websites. Confirmatory factor analysis and structural equation modeling were used to test the proposed research model. Results indicate that factors influencing purchase intention through virtual reality platforms are attitude, satisfaction, concentration, information quality, service quality, system quality, enjoyment, and time distortion. The findings could guide entrepreneurs and platform developers to develop a virtual reality platform suitable for e-commerce to enhance the consumer experience.

Keywords: Virtual reality, e-commerce, purchase intention, IS success model, flow theory.

INTRODUCTION

The rapid development of information technology has led to a change in customer behavior. Due to COVID-19, customers are forced to shop via e-commerce instead of physical stores. Customers' adoption of online purchasing is thus accelerated. This change in customer behavior may persist even after the pandemic pass (Kim, 2020). However, some limitations discourage online shopping, such as a lack of in-store shopping experience and distrust of products they have not seen in person, including the inconsistency between product display and actual products (Wang, Ko, & Wang, 2021). Additionally, most online stores only show images and product descriptions, which are insufficient for decision-making (Kim, 2020; Tamer, 2021). Hence, the biggest challenge for online shopping is to improve customer satisfaction and enhance purchase intention. In recent years, Virtual Reality (VR) has dramatically enhanced the online shopping experience. Major global retailers such as Amazon, Alibaba, and eBay have tried to apply VR to their e-commerce platforms to develop an online retail model as close to reality as possible (Xi & Hamari, 2021). VR refers to interactive display technologies that provide users with an immersive experience to explore computer-generated environments that are similar to the real world (An, Choi, & Lee, 2021; Jayaram, Connacher, & Lyons, 1997). VR could provide the most realistic experience of a product, service, or place for customers by using 3D computer graphics or VR. Thus, customers can experience the virtual environment as if they are there (Lee, Lee, Jeong, & Oh, 2020). However, only a few studies have explored the components that contribute to positive VR experiences and increase purchase intention (Dehghani, Acikgoz, Mashatan, & Lee, 2021; Jang, Hur, & Choo, 2019). Hence, this study raises an important question: 'what are the key factors that induce experience in the virtual world and influence customers' purchase intention?'. Responding to the research question, this study adopts the IS success model and flow theory to examine the technical and psychological mechanisms of VR experiences.

As new technology emerges, several studies have proposed the IS success model to explain the success of Information Systems (IS) and user adoption. Although the IS success model has been widely adopted in previous research (Kim & Hyun, 2016; Poushneh, 2018; Yoo, 2020), its application has been underexplored in the context of VR in e-commerce. Understanding the impact of VR using flow is a crucial component of user experience since the flow theory has been applied to several studies on VR in gaming and tourism contexts. (Hudson, Matson-Barkat, Pallamin, & Jegou, 2019; Kang, Shin, & Ponto, 2020; Zhao, Ham, & Vlist, 2018) Besides, flow is verified to have multiple dimensions, which are distinctively related to various psychological and behavioral effects (An et al., 2021). Kim and Hyun (2016) suggested that digital technologies, such as Augmented reality (AR), could affect telepresence. Thus, telepresence may be another applicable variable in this context. Mallam, Ernstsens, and Nazir (2020) propose time distortion as a part of the flow experience. However, telepresence and time distortion have both positive (Gao & Li, 2019; McLean & Wilson, 2016; Skadberg & Kimmel, 2004) and negative (An et al., 2021; Prashar, Sai Vijay, & Parsad, 2017) effects on attitudes depending on the usage context. Hence, a study on the impact of time distortion and telepresence in e-commerce must identify their roles using an empirical examination. In sum, this study's objectives are divided into two parts: 1) To study the factors affecting intention to purchase through VR platforms by applying the IS success model, including information quality, service quality, system quality, and satisfaction, and 2) To study the influence of flow theory affecting attitudes towards VR platform.

LITERATURE REVIEW

Theoretical Background

DeLone and McLean (1992) propose an IS success model to provide a comprehensive framework for measuring the performance of information systems and identify factors that attribute to IS success, including system quality, information quality, intention to use/ use, user satisfaction, and individual and organizational impacts. They later update the model to support a successful e-commerce system by including service quality as a new dimension of IS success and changing individual and organizational impact to net benefits (DeLone & McLean, 2003). This model enhances the understanding of user adoption behavior in various information systems. Its measures have been widely used in the literature, such as the study by Kim and Hyun (2016) investigated the effects of smartphone-based AR by including personalized service quality, system quality, and content quality in their research model. In addition, flow theory is applied to explain the impact of VR in the context of online shopping as a crucial component of facilitating user-computer interactions. Flow theory is presented by Csikszentmihalyi (1975). It refers to a psychological state or condition that occurs when a person is fully engaged or focused on an activity for an extended period and is unaware of the changes in time or environment (Mahfouz, Joonas, & Opara, 2020). Csikszentmihalyi (2014) explains that flow has primary components: a balance between skill and challenge, clear goals, and immediate responses. Many studies have used flow theory for understanding user behavior in various IS contexts (Bölen, Calisir, & Özen, 2021). In contrast, some studies state that concentration and enjoyment are the main components of flow because flow experience frequently leads to increase enjoyment and continuous involvement in a specific activity (Bölen et al., 2021; Hsu, Chang, & Chen, 2012). The element of flow may not be considered in all contexts since it yields positive or negative emotions and behaviors depending on an activity or situation. For example, people may regret the loss of time or money upon the flow state of gambling or playing a video game (An et al., 2021; Chen, Hsu, & Lu, 2018). However, this study will explore the flow experience using time distortion, concentration, telepresence, and enjoyment.

Hypothesis Development

Information quality is a critical factor in the success of an information system. It is defined as the characteristics of the information system's output or the information shown on a system. DeLone and McLean (2003) suggest that information should be personalized, complete, relevant, easy to understand, and secure. In the context of VR, information quality focuses on the virtual content generated by VR (Lee et al., 2020), which should be presented with a high degree of realism (David, Senn, Peak, Prybutok, & Blankson, 2021) and not too much information and images, which possibly overwhelm users (Poushneh, 2018). If the perceived quality of virtual content is high, users will more easily understand the content and focus on the VR experience (Gao & Li, 2019). Information quality has proven to be strongly associated with user satisfaction (Chen, Rungruengsamrit, Rajkumar, & Yen, 2013). High information quality implies that information systems provide the user with relevant information, which is critical for satisfying users' expectations (Kim, Hwang, Zo, & Lee, 2014). Moreover, the relationship between information quality and attitude is significant, especially in online shopping (Ingham & Cadieux, 2016). It is predicted that when customers perceive the high quality of virtual content, they will develop favorable attitudes toward VR (Lee et al., 2020). Therefore, the following hypothesis is proposed:

H1: Information quality has a positive influence on satisfaction with the VR platform.

H2: Information quality has a positive influence on attitude toward the VR platform.

Service quality refers to the quality of the support users receive from the system. In the context of VR, service quality enables users to choose what they want to see or explore based on their preferences, wants, or needs (Jung, Chung, & Leue, 2015). In this regard, online customization is a crucial feature of service settings in the online shopping experience that allows users to choose information or interactivity. Such variables are strongly associated with user evaluations of websites (Harris & Goode, 2010). High-quality service is required to achieve high levels of user satisfaction, which frequently results in positive behavioral intention (Brady & Robertson, 2001). Good services help consumers finish their online transactions and create good experiences (Gao & Li, 2019). Furthermore, the quality of the online service is an essential predictor of the consumer's attitude towards e-shopping. Inadequate services can negatively influence consumers' future behavior (Ingham & Cadieux, 2016). Therefore, the following hypothesis is proposed:

H3: Service quality has a positive influence on satisfaction with the VR platform.

H4: Service quality has a positive influence on attitude toward the VR platform.

The importance of system quality has been investigated in previous research (Jung et al., 2015; Kumar & Lata, 2021; Tsao, Hsieh, & Lin, 2016). System quality measures the technical capacities of an information system. For example, it can be measured through its ease of use, functionality, reliability, and accessibility (DeLone & McLean, 2003; Kim & Hyun, 2016). In the virtual environment, system quality reflects the degree to which a user can control the VR content in the system using actions such as flipping, zooming in/ out, and photo rotating (Kim & Hyun, 2016). Lee et al. (2020) found that system quality positively affects the psychological perception of users, which is the primary motivation affecting the use of virtual reality traveling sites and increasing a user's intention to visit the destination. Higher system quality is expected to lead to higher user satisfaction (DeLone & McLean, 2003). On the other hand, poor system quality indicates that VR functionality is difficult to use, unstable, or slow to show content. Thus, poor system quality could negatively affect the shopping experience (Yoo, 2020). In addition, system quality directly affects customers' attitudes toward online shopping (Ingham & Cadieux, 2016; Rana, Dwivedi, Williams, & Lal, 2015). Therefore, the following hypothesis is proposed:

H5: System quality has a positive influence on satisfaction with the VR platform.

H6: System quality has a positive influence on attitude toward the VR platform.

In the state of flow, people may lose the sense of time and perceive time faster than usual (An et al., 2021; Mallam et al., 2020) while engaged in a particular task and activity without being unaware of the passing time (Dehghani et al., 2021). Furthermore, time distortion occurs when users have intense or deep engagement in virtual reality environments (Chen, 2006). A person with a high level of time distortion will concentrate more on the flow than a person with a low level of time distortion (Han, An, Han, & Lee, 2020). Consumers tend to use websites to search for information and make purchases with the expectation of minimal effort and immediate information. They may not be aware of the passage of time (Prashar et al., 2017). Therefore, time distortion can have both a positive and a negative influence (McLean & Wilson, 2016). If users do not want to take longer than necessary, time distortion can cause a negative user experience when realizing that time was wasted in a state of flow (e.g., addiction or feeling guilty) (An et al., 2021). However, if VR establishes a positive experiential context with a managerial time requirement, then time distortion is expected to generate a positive evaluation of the experience (McLean & Wilson, 2016; Tan, Lee, & Hsu, 2015). This formed the basis of the following hypothesis:

H7: Time distortion has a positive influence on attitude toward the VR platform.

Concentration means that a person's level of attention is limited to one activity. It occurs when an individual engages in a task or an activity continuously for a while without recognizing distractions (An et al., 2021; Dehghani et al., 2021) and ignores other needs (Agarwal & Karahanna, 2000). Concentration is one of the critical experiential components of flow (An et al., 2021). Consumers who experience flow produce positive emotions that gradually influence attitudes (Lee & Chen, 2010). Consumers who engage in online purchases may better understand product descriptions and feel more confident in purchasing decisions (Ozkara, Ozmen, & Kim, 2017). This could help consumers to achieve their online shopping goals (Lee & Chen, 2010). Thus, they tend to return to the website to purchase more in the future (Chen et al., 2018). The effect of concentration on attitude is expected to be positive and significant, thus forming the basis of the following hypothesis:

H8: Concentration has a positive influence on attitude toward the VR platform.

VR aims to create a virtual environment around users (Han et al., 2020). Hence, telepresence is an essential component of VR (An et al., 2021; Dehghani et al., 2021) since it enables the feeling of being in a real-world location that is temporally and spatially distant from the user's physical location together with the feeling of leaving, which is the feeling of separation from the physical environment (Lee et al., 2020; Tussyadiah, Wang, Jung, & tom Dieck, 2018; Van Kerrebroeck, Brengman, & Willems, 2017). Skadberg and Kimmel (2004) point out that the level of telepresence is related to interaction and attractiveness. Therefore, increasing the level of telepresence could have a positive effect on the flow experience. A website with a high level of telepresence could lead consumers to believe that they are getting good information about the product, thus creating higher purchase intention (Gao & Li, 2019). Thus, telepresence is likely to have a positive effect on attitudes toward the website, which leads to the following hypothesis:

H9: Telepresence has a positive influence on attitude toward the VR platform.

Enjoyment refers to happiness while doing an activity and staying with that activity for an extended period without getting bored. (Furlong, Gilman, & Huebner, 2014). Enjoyment is one of flow's most frequently studied dimensions (Ozkara et al., 2017). Consumers' enjoyment during online purchases is strongly associated with their purchase attitudes and intention (Chen et al., 2018). Additionally, a study in the context of AR found that travelers' perception of enjoyment while using VR applications affects their attitudes towards choosing destinations (Tussyadiah et al., 2018). Wang et al. (2021) studied the role of flow experience in the context of AR. The results show that AR adds enjoyment to the simulated shopping experience and further encourages consumers' exploratory behavior, which directly affects consumers' purchase intentions. As previous research discovered, enjoyment directly impacts attitudes toward the website (Priyadarshini, Sreejesh, & Anusree, 2017; Selfia, Idris, & Abror, 2019). Therefore, the following hypothesis is proposed:

H10: Enjoyment has a positive influence on attitude toward the VR platform.

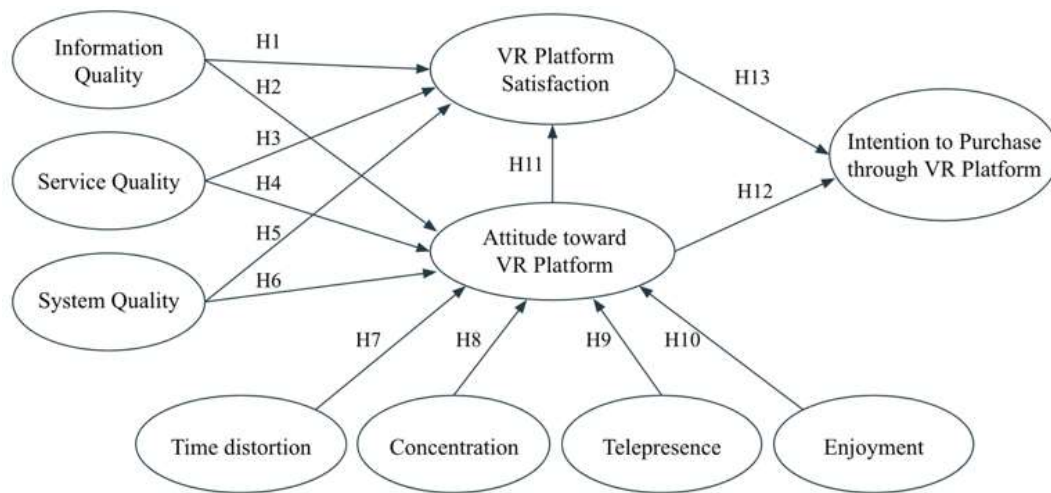
Attitude refers to an individual's positive or negative evaluative reaction to something specific. It can change as the person gains experience or knowledge about it (Hasan, 2010). Consumers' positive attitudes greatly influence purchase intention, which refers to the willingness to purchase goods or services through the website in the future (Harris & Goode, 2010). Another important factor that affects purchase intention is satisfaction. Satisfaction is critical to information system success and effectiveness (Jung et al., 2015). Consumers perceive satisfaction according to their personal experiences of the system. Improving user satisfaction in online environments is critical for increasing purchase intention (An et al., 2021). Several researchers have found that attitude (De Gauquier, Brengman, Willems, & Van Kerrebroeck, 2019; Van Kerrebroeck et al., 2017) and satisfaction (Dash, Kiefer, & Paul, 2021; Prashar et al., 2017; Rana et al., 2015) influence purchase intention. Therefore, the following hypothesis is proposed:

H11: Attitude has a positive influence on satisfaction with the VR platform.

H12: Attitude has a positive influence on purchase intention through the VR platform.

H13: Satisfaction has a positive influence on purchase intention through the VR platform.

Based on the above theoretical hypotheses, a research model showing the relationships between factors relating to IS success model and flow theory and purchase intention is established, as shown in Figure 1.



Source: This study.

Figure 1: Conceptual framework.

RESEARCH METHOD

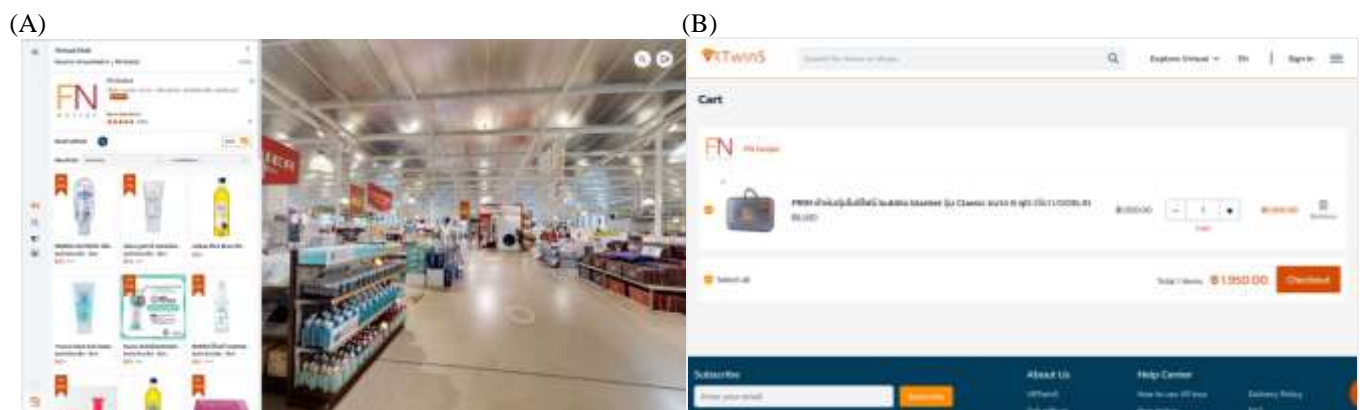
Sample and Data Collection

This study examined the effects of VR and other factors on customers’ intention to purchase. We chose ‘VR Twin Shop’ as the platform for our study, as shown in Figure 2. It was one of the few e-commerce VR-based platforms active in Thailand. The data was collected through online questionnaires (Google forms) from customers who have previously conducted online shopping through e-commerce websites. To ensure that the respondents had experience using the VR platform, they were asked to access the VR platform via a computer or laptop and search for a specific store. Then select the specified product and proceed to the pre-checkout step, as shown in Figure 3. The valid respondents must pass 2 out of 3 manipulation check questions about the platform elements. A total of 300 samples equally balanced between females and males were retained for analysis.



Source: Captured from VRTwinS (2022)

Figure 2: VR Twin Shop



Source: Captured from VRTwinS (2022)

Figure 3: (A) the respondents had to search for a specific store and product
(B) proceed to the pre-checkout step

Measurement Development

The questionnaires consist of 4 sections. The first section is an introduction to the VR platform also instructions on how to use the platform. The following sections are the demographic section and the manipulation check section that the respondents were required to answer three screening questions: “After pressing the ‘SHOP’ button in the ‘VR Twin shop’, how will the system be displayed?”, “When you enter the shop you will see a red promotion sign. What does that sign say?” and “In the checkout page, will the system display the price as the full price or the price after discount?”

The section about hypothetical factors consist of ten constructs measured using scales from previous research. These scales were modified and pretested to fit the context of the present study. The questionnaire included items about information quality (Delone & McLean, 2003; Kim & Hyun, 2016), service quality (Jung et al., 2015; Kim & Hyun, 2016), system quality (Delone & McLean, 2003; Kim & Hyun, 2016; Yoo, 2020), time distortion (Agarwal & Karahanna, 2000), concentration (Agarwal & Karahanna, 2000), telepresence (Han et al., 2020), enjoyment (Han et al., 2020), satisfaction (David et al., 2021), attitude (Ahn, Ryu, & Han, 2004; Porter & Donthu, 2006), and purchase intention (Ahn et al., 2004). All items used a five-point Likert scale ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). The constructs were validated using Confirmatory Factor Analysis (CFA) before testing the hypotheses using Structural Equation Modeling (SEM).

DATA ANALYSIS

Demographics

By using the quota sampling method, the respondents were similarly distributed between males (50%) and females (50%). The most significant percentage of respondents (49%) was aged 21 to 30, followed by those under 21 (33%). Most respondents received a bachelor's degree (67%). Further, we collected data about online shopping behavior and found that 62% of the respondents spent less than 500 Thai baht per transaction. While the categories of products that respondents purchased online the most were home accessories and lifestyle (30%), health and beauty (24%), and fashion (22%), respectively.

Measurement Model Evaluation

The assessment of reliability was assessed using Cronbach's alpha (CA) and Composite Reliability (CR) values. Convergent validity assessment was based on Average Variance Extracted (AVE) values. The Fornell–Larcker criterion was the approach used in this study to assess discriminant validity. This was done by comparing the square root of the AVE values with the latent variable correlations (Fornell & Larcker, 1981; Hair, Hult, Ringle, & Sarstedt, 2014). By considering the values, All Cronbach's alphas and AVE values were above the threshold of 0.5. CR values were higher than 0.7, and the AVE's square roots on each variable's diagonal were more significant than the correlation coefficients with other variables (Hair et al., 2014), as shown in Tables 1 and 2. This means all constructs were suitable parameters with appropriate reliability and validity.

Table 1. Indicator Reliability, Internal Consistency, and Convergent Validity

Constructs	CA	CR	AVE
Information Quality (INQ)	0.883	0.868	0.689
Service Quality (SEQ)	0.836	0.820	0.534
System Quality (SYQ)	0.844	0.868	0.621
Time Distortion (TD)	0.809	0.839	0.567
Concentration (CON)	0.883	0.874	0.636
Telepresence (TEL)	0.840	0.840	0.636
Enjoyment (ENJ)	0.876	0.860	0.619
Satisfaction (SAT)	0.888	0.876	0.638
Attitude (ATT)	0.850	0.841	0.570
Purchase Intention (PUR)	0.831	0.829	0.550

Table 2. Discriminant Validity (square root of AVE on diagonal).

	ATT	INQ	SEQ	SYQ	TD	CON	TEL	ENJ	SAT	PUR
ATT	0.755									
INQ	0.524	0.830								
SEQ	0.487	0.590	0.731							
SYQ	0.569	0.454	0.654	0.788						
TD	0.440	0.397	0.369	0.342	0.753					
CON	0.626	0.432	0.632	0.659	0.400	0.797				
TEL	0.362	0.239	0.342	0.439	0.364	0.381	0.797			
ENJ	0.443	0.369	0.400	0.442	0.274	0.543	0.330	0.787		

SAT	0.407	0.545	0.560	0.557	0.207	0.444	0.389	0.372	0.799	
PUR	0.604	0.497	0.482	0.485	0.295	0.548	0.407	0.398	0.594	0.742

Structural Equation Analysis

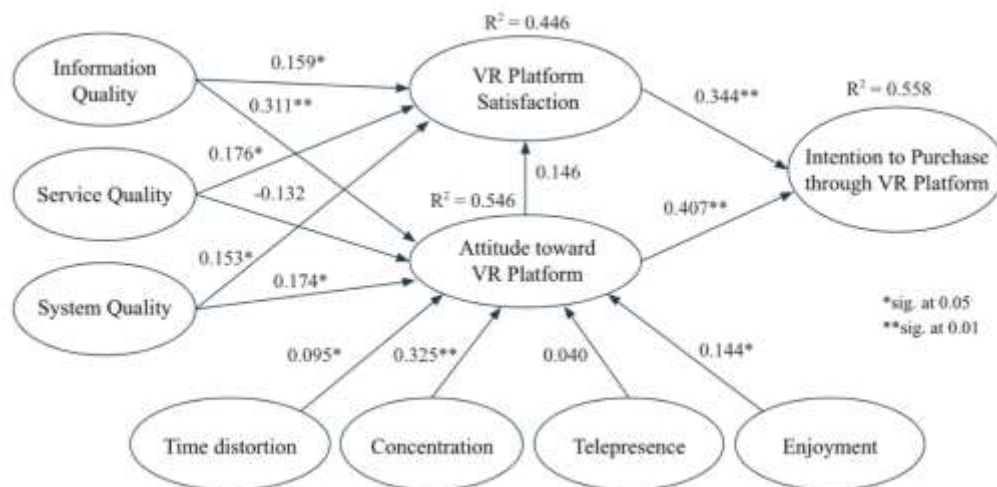
In confirmatory factor analysis, the fitting degree of the model was tested to determine how consistent the relationships in the model were with the collected data. The following fit indicators were explored: the Chi-Square (χ^2)/ Degree of Freedom (df) Ratio, the Goodness-of-Fit Index (GFI), and the Root-Mean-Square Error of Approximation (RMSEA). In addition, the indices such as the Root Mean Square Residual (RMR), the Comparative Fit Index (CFI), and the Normed Fit Index (NFI) were used as well. The corrected fitting test results were shown in Table 3, which demonstrated that most indicators reached the recommended value of model fitting (Hooper, Coughlan, & Mullen, 2007; Tabachnick & Fidell, 2007), both for CFA and SEM, so the overall modified models were good.

Table 3. CFA and SEM: Model fit index

Fit Measure	Good Criteria	Fit Indicators	Indicators Confirmatory factor analysis	Indicators Structural equation modeling
χ^2/df	< 2.00		0.963	1.011
GFI	> 0.90		0.914	0.906
NFI	> 0.90		0.926	0.921
CFI	> 0.90		1.000	0.999
RMSEA	< 0.08		0.007	0.006
RMR	< 0.05		0.023	0.024
P-value for a test of close fit	> 0.05		1.000	1.000

Source: This study.

The hypotheses were tested by examining the structural equation modeling and the impact of each factor. The results were largely positive effects of predictors, as shown in Figure 4 and Table 4.



Source: This study.

Figure 4. Standardized estimates for SEM

Table 4. Hypotheses Testing

Hypotheses	Relationship	Estimate	S.E.	C.R.	Test result
H1	INQ à SAT	0.159*	0.096	3.577	Supported
H2	INQ à ATT	0.311**	0.087	3.588	Supported
H3	SEQ à SAT	0.176*	0.103	1.846	Supported
H4	SEQ à ATT	-0.132	0.101	-1.305	Not Supported
H5	SYQ à SAT	0.153*	0.089	3.156	Supported
H6	SYQ à ATT	0.174*	0.081	2.145	Supported
H7	TD à ATT	0.095*	0.046	2.06	Supported
H8	CON à ATT	0.325**	0.078	4.16	Supported
H9	TEL à ATT	0.040	0.047	0.862	Not Supported
H10	ENJ à ATT	0.144*	0.080	1.001	Supported
H11	ATT à SAT	0.146	0.079	-0.399	Not Supported
H12	ATT à PUR	0.407**	0.064	6.323	Supported

H13	SAT à PUR	0.344**	0.061	5.682	Supported
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Source: This study.

Notes: **: P < 0.01; *: P < 0.05

DISCUSSION AND IMPLICATION

Discussion

This study aims to identify the influence of VR on customers' intention to purchase. Findings reveal that all dimensions of the IS success model (information quality, service quality, and system quality) significantly positively influence users' satisfaction and attitude, except for the relationship between service quality and attitude. Hence, it could be summarized that users may understand the platform's interface easily, or they do not use the platform long enough to encounter issues requiring support. The findings have similar insignificant results to the previous studies (Chen et al., 2013; Elsharnouby & Mahrous, 2015; Muljono & Setiyawati, 2019), which indicate that consumers develop attitudes only after purchasing products. Regarding the flow experience, the results show that time distortion, concentration, and enjoyment are the main components of flow in the context of VR e-commerce. All of them positively influence customers' attitudes. However, although telepresence in VR could affect users' excitement, a non-significant relationship is found between telepresence and attitude. Jang et al. (2019) report the same outcome, showing that telepresence with VR technology could not attract consumers to online shopping. Telepresence creates a positive attitude towards the platform only when consumers perceive the sensation of being transported to the virtual world (Lee, 2018). Surprisingly, the findings reveal that the relationship between attitude and satisfaction is not supported. That could explain it because many respondents have never used a VR platform before; they have no expectations before trying the platform, according to the instruction of this research. There is also no comparison between expectations and the results obtained after trying the platform. Therefore, it cannot be assessed whether satisfaction is achieved or not. Finally, this study found a positive effect of attitude and satisfaction on purchase intentions, which confirms previous research findings indicating that VR encourages a positive psychological stage that leads to the behavioral intention of users (Jang et al., 2019; Kang et al., 2020; Xi & Hamari, 2021).

Implications

For theoretical implications, this study contributes to the existing knowledge by applying the IS success model (Delone & McLean, 2003) and flow theory (Csikszentmihalyi, 1975) to the VR e-commerce context, which has been rarely investigated in the literature. The findings confirm all dimensions of quality in the IS Success model toward VR platform satisfaction and show that consumer satisfaction is a significant predictor of purchase intention in VR e-commerce. Moreover, a significant contribution of this study is that it reflected the main components according to flow theory in the context of the VR shopping experience, including time distortion, concentration, and enjoyment. This study can induce future researchers to apply the research framework to investigate other outcomes such as repurchase and word-of-mouth, in addition, to purchase intention, in the context of e-commerce with VR technology. This study also provides valuable practical implications for VR developers and entrepreneurs. First, given that the quality of IS (Information Quality, Service Quality, and System Quality) affects purchase intention, this study shows that customers are more likely to purchase through VR platforms that satisfy them the most. Once customers have a satisfying experience or a favorable evaluative reaction toward the VR platform, they may choose to purchase goods and services in the future. Second, the study findings suggest developing users' perception of VR platform performance by enhancing system design and functionalities. Virtual content that accurately displays images and colors is easy to understand, straightforward and realistic and will enhance the quality of information delivered through the VR platform. In terms of service and system quality, the design of the VR platform should allow customers to easily access it from various devices such as smartphones, tablets, etc. The control of VR functions must be easy; the system can process virtual contents properly and immediate interactions between the user and media. Finally, this study shows that flow experience (Time Distortion, Concentration, Enjoyment) positively influences customers' attitudes. Developers should design features that strongly support customers' enjoyment and engage them to entirely focus on the platform without realizing how much time has passed. Retail businesses should consider those aspects of the platform as one of the selling channels.

LIMITATIONS AND FUTURE RESEARCH

Customer behavior is continually changing in online shopping. Especially during the COVID-19 pandemic, VR can be used to increase customers' experience and lead to purchase intention. This study explores the factors affecting the intention to purchase through VR platforms. This research has shown a significant positive relationship between the factors of these models. Nevertheless, the factor of telepresence should be further studied in the context of online shopping through VR platforms. A few limitations were encountered in this study. The age of this study's sample was disproportionate as most respondents were under 30. This may cause bias in the data results because they can quickly adopt new technologies. Therefore, verifying whether the results are still valid in other age groups is necessary. This study could be replicated in the future with larger and broader sample size. The findings may also be limited because the VR characteristics and flow measurements were only applied to web-based virtual environments. It would be interesting to determine if there is a difference between non-immersive, semi-immersive, and fully-immersive VR in terms of how the technology affects purchase intention. Future studies should investigate how devices or gadgets influence VR experiences.

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Factors influencing patient's medical choice behavior on Internet Medical: The perspective of trust

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ABSTRACT

Based on the source credibility model and trust transfer theory, this study examined the influence of physician's personal attributes and word-of-mouth on patients' medical choice in online healthcare communities, and explored trust transfer from online to offline channel as well as the moderating effect of disease risk on the influence of ability trust and honest trust. Using data from Good Doctor Online, the results revealed that ability trust, benevolence trust, honest trust, and transference trust based on word-of-mouth all had a positive impact on the patients' medical choice despite slight differences between channels in terms of specific proxies and degree of influence. Disease risk moderated the relationship between ability trust and honest trust and patients' medical choice. Trust transfer from online channel to offline channel had not been verified.

Keywords: Internet medical, trust source, trust transfer, medical choice.

INTRODUCTION

With the rapid development of communication technology and the continuous improvement of people's health awareness, online healthcare has become popular. Online healthcare refers to medical consultation or service on the Internet, which provides convenient and efficient medical knowledge popularization and medical services through various forms such as medical information inquiry, remote consultation and treatment. Internet medical industry breaks the boundaries of time and space and thus effectively improves the scarcity and unbalanced distribution of medical resources, providing possibility for patients with low income or limited mobility to use high-quality medical services and creating a basic condition for medical and healthcare service equity. However, online healthcare faces a series of challenges in its development process, as F. Yang et al. (2021) have noted, "problems such as user privacy, qualifications of practitioners, and responsibilities and obligations of both doctors and patients have become prominent". Consequently patients may face difficulties ascertaining service quality in order to make choices about their available treatment options, which hinders patient trust in Internet medical services. Healthcare service is a high-credence service, in which trust has a profound impact on the physician-patient relationship and thus affects the sustainability and market competitiveness of online healthcare. Therefore, it is an urgent demand and a key challenge for online healthcare communities to understand patients' psychology of selecting physicians so as to improve patients' trust to promote consulting intention.

However, existing research on patients' medical choice in online healthcare community mainly focuses on the influencing factors of online word-of-mouth, merely explores other attributes on online healthcare platform and considers trust transfer from online to offline channel. Lu and Wu (2016) solely focused on patients' ratings of physicians' technical quality and functional quality, yet more physician-related information is presented on online healthcare websites, such as number of provided services and physicians' profiles and specialties, how these factors affect patients' medical choice has not been demonstrated. Most of existing studies focus on patients' online behaviour in online healthcare, ignoring patients' behaviour of online booking through online healthcare websites and service in hospital. Zeng (2019) only considered patients' online medical choice measured by increment of online consultations and explored the influence of various factors on patients' selection of physician. In addition, most existing studies viewed from the perspective of patients, for instance, Hong (2020) explored the antecedents and outcomes as well as evolutionary process of physician-patient trust combined the whole process of using Internet medical from the patient's perspective, while there has been very little research exploring from the trustee's perspective (i.e., physician's perspective). Since physician-patient trust is mutual, it is necessary to study its influencing factors from the perspective of the trusted party and consider both online and offline patients' behaviour.

This paper focuses on patients' medical choice on the website, develop a theoretical model of patients' online and offline medical choice from the perspective of trust. Using data from the *Good Doctor Online* platform, this study aims to 1) examines the influencing factors of patients' online consultation and office appointment, 2) explores the trust transfer from online to offline channel, 3) the moderating effect of disease risk on physician's ability trust and honest trust.

LITERATURE REVIEW AND HYPOTHESES

Physician-patient Trust in Online Healthcare

Trust is the cornerstone of interpersonal interactions, and physician-patient trust is especially important in online healthcare. Research of user trust on the Internet have a long history both at home and abroad and have already obtained a wealth of results. Srinivasan (2004) pointed out the role of trust in e-commerce from the perspective of transaction. Zhang and Zhong (2012) used the basic theories and methods of social network analysis to study the trust relationship in e-commerce. However, only a few researchers have been interested in investigating online healthcare communities and their research has been mainly based on online text data. For example, Huang et al. (2019) developed a model that examined the relationships between three dimensions of social capital and the provision of informational and emotional support, and engagement in companionship activities in healthcare virtual support communities and tested it based on user-generated text. Hao and Zhang (2016) used “an automated text-mining approach to analyze a large amount of unstructured textual data of Web-based physician reviews” to understand the voice of health consumers. However, online text data is only part of the information source in online healthcare community, and patients collect information from various sources such as physicians’ patient experience and number of articles shared by physicians in personal public account, to reduce their decision-making risk and make medical choice. Therefore, it is insufficient to focus only on online text data such as comments. Other quantitative attributes displayed on the website should also be taken into account. However, only a very limited number of studies incorporate these attributes on patient trust.

Furthermore, existing research on patient trust in online healthcare communities has been mainly conducted from the perspective of the trust-giver to study patients’ subjective perceived trust. For example, Mun et al. (2013) considered patients’ perceptions and found that perceived information quality and perceived risk significantly affected users’ trust in online healthcare information. Deng and Hong (2017) also explored from patients’ perspective and found that personal trust tendency, credibility of physicians, hospitals and platforms, perceived risk and perceived benefit jointly had significant effects on patient trust online. However, in the physician-patient trust relationship, the trustees (i.e., physicians) are not passive that they can take initiative to win more patients’ trust by enhancing self-presentation in their homepages in online healthcare community. Therefore, to better understand how to enhance patients’ trust in physicians, more studies from the trustee’s perspective are needed.

Finally, existing studies have mainly focused on the patients’ online medical choice, ignoring office appointments through online healthcare communities and service in hospital. However, *Good Doctor Online*’s office appointment has reached 4.95 million as of July 2022, indicating a large group of patients book online service in hospital and deserve corresponding attention. Therefore, this paper attempts to explore how physicians’ information attributes and online word-of-mouth affect patient trust and thus medical choice from the trustee’s perspective, and considers both patients’ online consultation and offline appointment.

The Source Credibility Model and Hypotheses

Trust source is one of the key issues in trust domain. McAllister (1995) conducted in-depth study based on the results of previous studies and proposed a source credibility model which is widely recognized by scholars and widely used. The model has three dimensions namely ability, benevolence, and integrity, which can effectively explain the trust source credibility (Mayer et al., 1995).

According to Mayer et al. (1995), ability trust refers to trust received by the trustee due to influential skills or talents to do a certain job in a particular field or ability to provide better products or services to the trust-giver. Benevolence trust is the trustee’s willingness to provide help or service to the trust-giver out of altruistic motives. When feeling the friendliness of the trustee, the trust-giver will enhance trust and maintain a long-term trust relationship with the trustee. Honest trust refers to the trustee’s initiative to show sincere and honest attitude by presenting reliable information to the trust-giver, which reduces the risk of information asymmetry and thus enhances trust-giver’s perceived trust.

These three dimensions can be directly reflected from trustee’s attributes. McKnight and Chervany (2001) noted that “if the trustor has high beliefs in the competence, integrity, benevolence, and predictability of the trustee, then the trustor will have the highest level of willingness to depend on the trustee”. According to Kuan and Bock (2007), “customer believes that the retailer’s online operations is able (because of competence) and willing (due to benevolence and integrity) to deliver the products purchased” which increases their purchase intention. In the field of online healthcare, physician providing online medical services is an important trust source and various information presented in online healthcare community is a driving force of trust. Thus physician’s personal attributes and website’s information attributes reflect the trust source credibility.

The impact of ability trust

Ability trust influences patient choice. Patients’ expectations for future treatment outcomes raise with the physician’s high degree of medical skills and competence.

Physician’s medical title is ranked by his/her academic level, patient experience and professional qualification, which can reflect the physician’s competence level and is one of the sources of ability trust (Zeng, 2019). It enhances patients’ acceptance and trust in physicians and promotes their medical choice. In this regard, this paper proposes the following hypothesis.

H1a: Physician's medical title positively influences patients' medical choice (a: online medical choice, b: offline medical choice).

Patient experience is the result of a physician's combination of medical theory and clinical practice and innovation over the years, which can be reflected by the total number of existing patients which is presented in online healthcare community. The higher the total number of patients is, the more experienced the physician is, which reflects his/her medical ability. Therefore, the following hypothesis is proposed.

H1b: Physician's patient experience positively influences patients' medical choice (a: online medical choice, b: offline medical choice).

Hospital level is a classification of hospitals based on hospital size, scientific research direction, scientific talent and medical hardware and equipment. In the traditional medical environment, patients tend to go to better hospitals. Higher-level hospital usually has more advanced equipment and medical skills as well as more abundant medical resources, which can enhance patients' expectations for treatment results. Accordingly, the following hypothesis is proposed.

H1c: Hospital level positively influences patients' medical choice (a: online medical choice, b: offline medical choice).

Wan et al. (2021) found that medical resources are highly correlated with regional GDP and pointed out that "medical resources are unevenly distributed in each province, with the top cities typically showing overconcentrations". People tend to believe that more economically developed the city where the hospital is located, the more abundant its medical resources are, which in turn promotes patients' medical choice. Therefore, this paper proposes the following hypothesis.

H1d: City economic level positively influences patients' medical choice (a: online medical choice, b: offline medical choice).

The impact of benevolence trust

In online healthcare communities, physicians can take initiative to publish articles in their personal public account, such as guide to medical treatment and knowledge sharing, facilitating patients' appointment and follow-up visit and answering disease-related questions that patients are concerned about, which shows their consideration for patients and helps to win patients' benevolence trust. Therefore, number of shared articles can reflect the benevolence of physicians (Lin, 2020), reducing patients' perceived risk of opportunistic behaviours committed by physician and making them believe that physician will not harm their interests. Based on this, this study proposes the following hypothesis.

H2a: Number of articles shared by physicians positively influences patients' medical choice (a: online medical choice, b: offline medical choice).

Physicians can choose which online healthcare service to open out of his/her own will, such as consultation through telephone, question-and-answer, consultation with image. It can be implied that a physician who provide more kinds of service is more considerate for patients. Therefore, higher number of provided services implies higher physician's benevolence, enhancing patients' trust and promoting medical choice. Accordingly, the following hypothesis is proposed.

H2b: Number of provided services positively influences patients' medical choice (a: online medical choice, b: offline medical choice).

Report after hospital visit is an exclusive benefit provided by physicians to outpatients. Outpatients can report by scanning the physician's QR code and receive a free consultation package (usually includes three free replies from the physician and valid for one month). Through report after hospital visit, patients can regularly give feedback to and timely consult with the physician, and physician can in turn send the patient attention points regularly. In this regard, number of reports after hospital visit reflects the physician's consideration for the patients, which enhances benevolence trust. Since the total number of reports after hospital visit correlates with how long the physician's website has been opened, monthly average number of reports after hospital visit can serve as a better signal of how often the physician provides the convenient service to patients. This study proposes the following hypothesis.

H2c: Average monthly number of reports after hospital visit positively influences patients' medical choice (a: online medical choice, b: offline medical choice).

The impact of honest trust

In e-commerce environment, public disclosure of merchants' truthful information can influence consumers' purchase intentions (Oliveira et al., 2017). Similarly, information disclosure reflects a physician's honest attitude in online healthcare environment and patients prefer physicians with high information disclosure since medical choice is related to the patients' health condition. Therefore, this paper proposes the following hypothesis.

H3: Information disclosure positively influences patients' medical choice (a: online medical choice, b: offline medical choice).

Trust Transfer theory and Hypotheses

Trust transfer process is a cognitive process in which a subject's trust in a familiar target can be transferred to another target by virtue of certain associations that "when the trustor trusts in the third person and there is a close relationship between the trustee and the third person, the trustor's trust in the third person will be transferred to the trustee". It is an effective mechanism for trust construction, which refers to the cognitive process of formed maintainable trust transferring between credible entity and unknown entity or between familiar environment and unfamiliar environment and building new trust. It has been revealed that trust transfer affects purchase decisions. Kuan and Bock (2007) claimed that a customer's online trust in a brick and click retailer can be formed due to other individuals' experiences with the retailer, leading to purchasing.

On the *Good Doctor Online* platform, patients can express gratitude to physicians by writing thank-you letters for free or buying virtual gifts. The virtual gift reflects existing patients' acceptance of the physician's medical skills and service attitude.

Virtual gift rate is the ratio of the total number of virtual gifts received by the physician to the total number of his/her patients. Higher ratio implies larger proportion of existing patients are willing to pay extra money and time to express their appreciation to the physician, which shows a higher trust level of existing patients. According to trust transfer theory, this will enhance potential patients' perceived trust in the physician and thus promote medical choice. Therefore, this paper proposes the following hypothesis.

H4a: Virtual gift rate positively influences patients' medical choice (a: online medical choice, b: offline medical choice).

Online review is experience or feedback after consultation or after hospital visit. Previous research has revealed a positive correlation between the number of online reviews and product sales. Chevalier and Mayzlin (2006) examined the effect of consumer reviews on relative sales of books on Amazon.com and BarnesandNoble.com and proposed that "an increase in the number of reviews at Amazon relative to BN.com continues to improve sales at Amazon relative to BN.com". In general, consumers are more willing to share their consumer experience by making online reviews if they perceive better attitude of the seller. In the Internet medical field, higher rate of online reviews means larger proportion of patients are willing to actively evaluate the physician out of acceptance of the physician's service, which provides potential patients with more information about the physician's service and reduces trust risk, thus promotes medical choice. Accordingly, this paper proposes the following hypothesis.

H4b: Review rate positively influences patients' medical choice (a: online medical choice, b: offline medical choice).

It has been confirmed that online ratings can promote purchase behaviour. Hanauer et al. (2014) surveyed a nationally sample of the US population about their knowledge and use of online ratings for medical selection and fifty-nine percent of respondents reported physician rating sites to be important when choosing a physician. Similarly, in healthcare, online ratings have an impact on patients' medical choice. The recommendation level is calculated by the website based on patients' votes in the past two years and physician's service ratings, which values between 0 and 5. The higher it is, more recommended the platform for the physician is, which indicates higher existing patients' satisfaction and platform's acceptance for the physician and promotes potential patients' medical choice. Therefore, this paper proposes the following hypothesis.

H4c: Recommendation level positively influences patients' medical choice (a: online medical choice, b: offline medical choice).

According to channels, the process of trust transfer can be divided into intra-channel one and inter-channel one. The former refers to trust transfer between different objects in the same channel while the latter refers to trust transfer between different environments. Whatever type of trust transfer, trust accumulated in one channel may affect the evaluation of products or services in the same channel or another channel over time (Lee et al., 2007).

In e-commerce, studies have demonstrated that trust offline can be transferred to initial trust online through process integration. Similarly, in online healthcare, inter-channel trust transfer may also exist. Patients develop trust in the physician who provides medical service in an online healthcare website, which may be transferred from online to offline and form trust offline. This study will specifically analyze whether trust developed online can be transferred to offline environment. The following hypothesis is proposed.

H5: Patients' online medical choice positively influences patients' offline medical choice.

The Moderating Effect of Disease Risk and Hypotheses

In an online healthcare domain, the influencing mechanism of patients' medical choice can be influenced by disease type. Patients with high-risk diseases require higher quality services compared to those with low-risk diseases (H. Yang et al., 2015). Their psychological characteristics vary with different disease risks. High-risk patients will be more motivated by the hope of finding a higher quality physician (Lu & Wu, 2016). Because of its association with mortality, patients with high-risk diseases are more rational and cautious and care more about objective facts about physicians, and have more motivation to undertake more cognitive effort to attain a better physician (Cao et al., 2017). McAllister (1995) divided organizational trust into affective trust and cognitive trust based on different mechanisms of interpersonal trust building. The former is based on human interaction and attraction (Chua et al., 2008); while the latter is based on rational calculation and mutual exchange and refers to belief in each other's ability, honesty and other personal characteristics based on rational judgment (McAllister, 1995). According to this definition, it is clear that ability trust and honest trust in the source credibility model belong to cognitive trust. Patients with high-risk diseases will undertake more cognitive effort to process objective factual information and build cognitive trust. They may pay more attention to the perception of ability and honesty of physicians, that is, they hope to find physicians with higher medical skills or more information transparency, rather than solely a physician with high benevolence. Based on this, the hypotheses about moderating effect of disease risk are proposed.

H6a: Disease risk positively moderates the relationship between physician's medical title and patients' medical choice (a: online medical choice, b: offline medical choice).

H6b: Disease risk positively moderates the relationship between physician's patient experience and patients' medical choice (a: online medical choice, b: offline medical choice).

H6c: Disease risk positively moderates the relationship between hospital level and patients' medical choice (a: online medical choice, b: offline medical choice).

H6d: Disease risk positively moderates the relationship between city economic level and patients' medical choice (a: online medical choice, b: offline medical choice).

H6e: Disease risk positively moderates the relationship between physician's information disclosure and patients' medical choice (a: online medical choice, b: offline medical choice).

According to the above hypotheses, a hypothetical model of patients' medical choice in online healthcare community is constructed. The conceptual model is depicted in Figure 1.

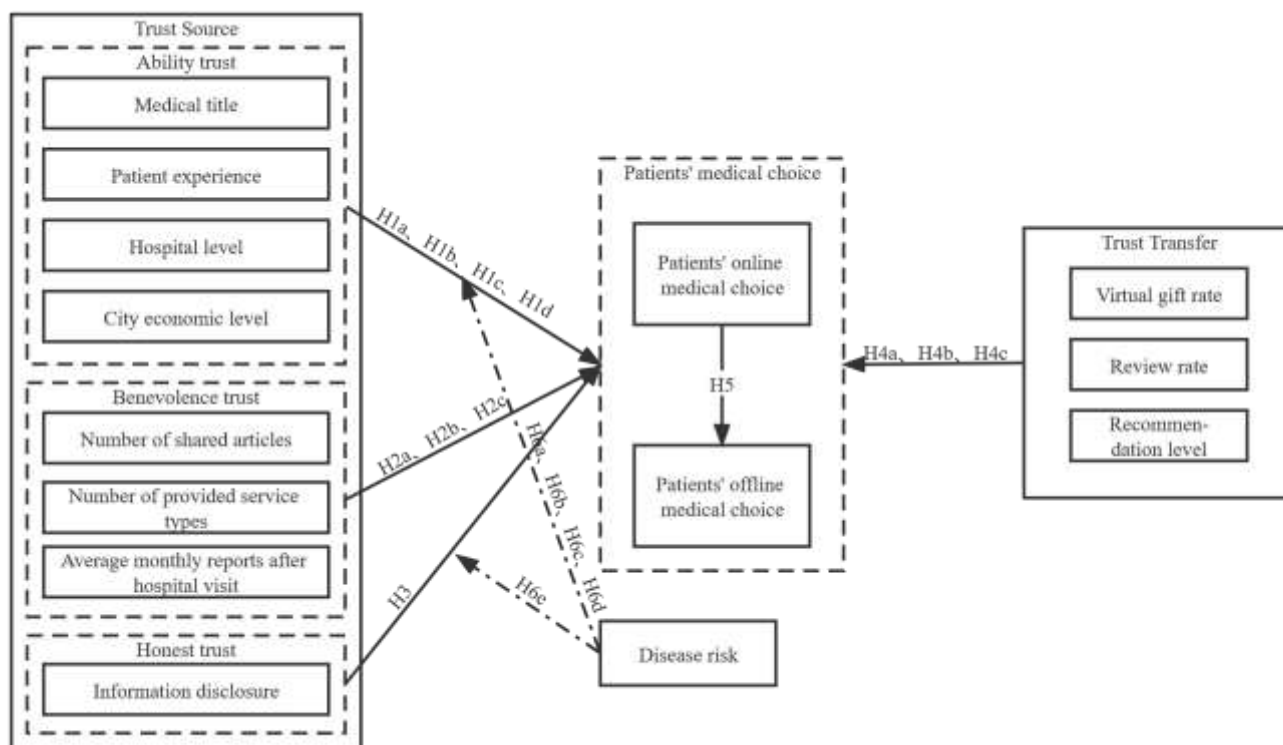


Figure 1: Conceptual Model.

DATA AND VARIABLES

Data Collection

Good Doctor Online is a leading online healthcare community in China. As of April 2022, 890,000 physicians from over 10,000 regular hospitals in China have been listed on the *Good Doctor Online*, of which 245,890 physicians have completed real-name registration to provide online consultation. Patients can use its appointment platform to register with 2883 hospitals and 22,879 physicians at home and it has helped more than 4.87 million patients with hospital visits successfully. Thus *Good Doctor Online* platform is chosen for our empirical research.

The research used Houyi collector to crawl data by defining rules. First, this research collected the URLs of all physicians in the recommendation list for each disease and then crawled the specific data in the physician's personal homepage through the URLs, including the physician's name, medical title, number of online consultations, the hospital where s/he works, number of shared articles in his/her personal public account, number of reports after hospital visit, number of thank-you letters and gifts, number of reviews and opening time of his/her homepage. The research accessed the website of the hospital in which the physician works for hospital level and location, accessed the service page for service types provided by the physician, accessed the mobile appointment page for the number of appointments, and accessed the physician's profile page for the text of his/her profile and specialty.

The research collected 16 disease categories with 23,555 physicians' website data from April 7, 2022 to April 8, 2022 and collected again after two weeks to calculate the increment of new patients. Excluding the samples with missing values, the cross-sectional data numbered 10,931, which was used to explore the influencing factors of patients' online medical choice.

Few physicians opened both online consultation and office appointment services in the *Good Doctor Online* platform, so this paper screened out a total of 4,042 physicians who opened both online and offline services from the above data sample, to explore the influencing factors of patients' offline medical choice and trust transfer from online to offline channel.

Variables

The dependent variables were patients' online medical choice (OnlinePatient) and patients' offline medical choice (OfflinePatient). Patients' online medical choice (OnlinePatient) was also an independent variable in Model 3 and Model 4. According to Zeng and Guo (2018), two-week online consultation increment can serve as a proxy for patients' online medical choice. Average monthly office appointment was used to measure patients' offline medical choice.

Based on the studies of Hong (2020) and Zeng and Guo (2018), the following independent variables were constructed and measured. Physician's medical title (MedicalTitle), patient experience (TotalPatient), hospital level (HospitalLevel), and city economic level where the hospital locates (CityGDP) represented ability trust; number of shared articles (Article), number of provided service types (ServiceNum), and average monthly reports after hospital visit (AveReport) represented benevolence

trust. Information disclosure (Disclosure) represented honest trust. Virtual gift rate (TotalGiftRate), review rate (ReviewRate) and recommendation (Recommend) were proxies for trust transfer. Qualitative variables were quantified: medical titles were mapped into integers, with chief physician, chief technician and chief rehabilitator as 4, deputy chief physician, deputy chief technician and deputy chief rehabilitator as 3, attending physician as 2, physician as 1, and the rest as 0. Hospital level was judged by the country as Level 3 (best), 2, and 1 (worst). City economic level was measured by GDP per capita of each province in the seventh census data. Average monthly reports after hospital visit was the ratio of the number of reports after hospital visit to number of months since the physician's homepage has been opened (i.e., average monthly reports after hospital visit = number of reports after hospital visit / number of months since the physician's homepage has been opened). Information disclosure was measured by word count of the physician's specialty and profile. Virtual gift rate was the ratio of the total number of virtual gifts to physician's total number of patients (i.e., virtual gift rate = (number of thank-you letters + number of gifts) / total number of patients). Review rate was the ratio of the number of reviews to total number of patients (i.e., review rate = number of reviews / total number of patients).

The disease risk (Risk) was selected as a moderator variable. According to the *Chinese Health Statistics Yearbook in 2020*, which lists the mortality rate of various diseases, eight high-risk diseases and eight low-risk diseases were selected in this paper. The high-risk diseases included coronary heart disease, diabetes, cerebral infarction, leukemia, liver cirrhosis, nephritis, arrhythmia and pancreatitis. The low-risk diseases included liver disease, menstrual disorders, hypertension, hyperlipidemia, insomnia, gastritis, headache and depression. High-risk diseases and low-risk diseases were expressed as 1 and 0, respectively. To control the effect of other possible factors on patients' medical choice, the research included how long the physician's homepage has been opened (OpenYear) as control variable.

The definitions and specific measurements of each variable are shown in Table 1.

Table 1: Variables description.

Variable type	Variable name		Description	Abbreviation
Dependent variable	Patients' medical choice	Patients' online medical choice	Two-week online consultation increment	Online Patient
		Patients' offline medical choice	Average monthly office appointment, i.e., total number of office appointment / number of months since the physician's homepage has been opened	Offline Patient
Independent variable	Ability trust	Medical title	The physician's medical title, chief physician, chief technologist, chief rehabilitator is 4, deputy chief physician, deputy chief technologist, deputy chief rehabilitator is 3, attending physician is 2, physician is 1, the rest is 0	MedicalTitle
		Patient experience	Total number of consultation	TotalPatient
		Hospital level	Hospital level which the physician works in, judged by the country as Level 3 (best), 2, and 1 (worst)	Hospital Level
		City economic level	Measured by GDP per capita of each province based on data from the 7 th Census data	CityGDP
	Benevolence trust	Number of shared articles	Total number of articles shared by physician on personal public account	Article
		Number of provided service types	Number of service types provided by physicians in online healthcare community	ServiceNum
		Average monthly reports after hospital visit	Average monthly number of reports after hospital visit, i.e., number of reports after hospital visit / number of months since the physician's homepage has been opened	AveReport
	Honest trust	Information disclosure	Word count of the physician's specialty and profile	Disclosure
	Trust transfer	Virtual gift rate	Rate of received virtual gifts, i.e., (number of thank-you letters + number of gifts) / total number of patients	TotalGift Rate

	Review rate	Review rate of physicians, i.e. number of reviews / total number of patients	ReviewRate
	Recommendation level	Recommendation level provided by platform, with values between 0 and 5	Recommend
Moderator variable	Disease risk	When the disease is high-risk, the variable equals to 1. Else equals to 0	Risk
Control variable	Opening year	How long has the home page existed	OpenYear

Variables Description

Dependent variables (i.e., patient's online medical choice and patient's offline medical choice) and some independent variables (i.e., patient experience, number of shared articles, average monthly reports after hospital visit, information disclosure, virtual gift rate, and review rate) show positive skewers distribution, so the research transformed these variables by taking logarithm ($\ln(x+1)$) to make the data scaled to the same magnitude and correct the skewness. Hospital level shows negative skewers distribution, so this study first converted it to a positively skewed distribution with the formula: $HospitalLevel_reflect = MAX(HospitalLevel) - HospitalLevel$, and then logarithmically transformed the mapped value. The skewness of most variables were controlled to be below 3 after the logarithmization process. Descriptive statistics of online sample and offline sample are shown in Table 2 and Table 3, respectively.

Table 2: Descriptive statistics of online sample

VARIABLES	N	mean	sd	min	max	skewness
lnOnlinePatient	10,931	0.806	1.164	0	7.042	1.392
MedicalTitle	10,931	3.545	0.666	0	4	-1.340
lnTotalPatient	10,931	5.528	2.212	0.693	11.19	-0.390
lnHospitalLevel_reflect	10,931	0.009	0.0868	0	1.099	10.08
CityGDP	10,931	10.78	4.410	3.600	16.49	0.132
lnDisclosure	10,931	5.873	0.840	2.079	9.206	-0.965
lnArticle	10,931	1.498	1.575	0	11.46	0.790
ServiceNum	10,931	2.350	1.088	0	8	-0.677
lnAveReport	10,931	1.053	1.171	0	6.546	1.003
lnTotalGiftRate	10,931	0.162	0.255	0	3.784	4.664
lnReviewRate	10,931	0.273	0.466	0	4.111	3.163
Recommend	10,931	3.563	0.387	2.400	5	1.626
Risk	10,931	0.415	0.493	0	1	0.344
OpenYear	10,931	7.971	3.635	0	14	-0.162

Table 3: Descriptive statistics of offline sample

VARIABLES	N	mean	sd	min	max	skewness
lnOfflinePatient	4,042	0.732	0.812	0	5.599	1.434
MedicalTitle	4,042	3.566	0.608	0	4	-1.245
lnTotalPatient	4,042	6.531	1.818	0.693	11.19	-0.725
lnHospitalLevel_reflect	4,042	0.0112	0.0985	0	1.099	9.188
CityGDP	4,042	12.16	4.239	3.600	16.49	-0.437
lnArticle	4,042	2.046	1.654	0	8.130	0.378
ServiceNum	4,042	2.669	0.959	0	7	-0.950
lnAveReport	4,042	1.474	1.221	0	6.546	0.524
lnDisclosure	4,042	6.046	0.772	2.079	8.861	-0.973
lnTotalGiftRate	4,042	0.124	0.173	0	3.784	7.582
lnReviewRate	4,042	0.160	0.288	0	4.111	5.545
Recommend	4,042	3.720	0.446	2.700	5	1.224
lnOnlinePatient	4,042	1.325	1.305	0	7.042	0.729
Risk	4,042	0.381	0.486	0	1	0.488
OpenYear	4,042	8.219	3.637	0	14	-0.286

According to the descriptive statistics, in the dimension of ability trust, physician's medical title and hospital level have high mean values and negative skewness (i.e., distributed in a left-skewed distribution), which indicates that physicians and hospitals of the platform are of high level. As for physician's patient experience, its standard deviation and range are both large, indicating obvious differences between different physicians' patient experience. In the dimension of benevolence trust, number of shared articles is highly discrete, showing stark differences between physicians' attitudes toward sharing articles. As for number of provided service types, its mean value is between 2 and 3, with 8 being the maximum value, which shows that most physicians have only opened a few services. In the dimension of honest trust, physicians' information disclosure is discrete,

showing that physicians' attitudes toward personal profiles and specialties differ greatly. In terms of trust transfer, virtual gift rate and review rate both show a right-skewed distribution.

The mean value of the control variable opening year is close to 8, indicating that physicians in *Good Doctor Online* platform have been in place for a long time overall and the platform have been developed for a long time. The dependent variables patients' medical choice have significant differences and great discretion, so studying the influencing factors of patients' medical choice has strong practical implications.

No variance inflation factor (VIF) statistics for the variables are greater than 6, which indicates the absence of multicollinearity. The correlations of variables are shown in Table 4 and Table 5, respectively. Main independent variables are correlated significantly with the dependent variable, consistent with the hypotheses. In the online sample, 97.80% of the correlation coefficients are below 0.7, and the vast majority are below 0.4; in the offline sample, 98.06% are below 0.7, and the vast majority are below 0.4. Thus, there isn't high linear correlation between independent variables and it is suitable for regression model.

Table 4: Correlations of variables of online sample.

	lnOnline Patient	Medical Title	lnTotal Patient	lnHospital Level_ reflect	CityGDP	lnArticle	Service Num
lnOnlinePatient	1						
MedicalTitle	-0.038***	1					
lnTotalPatient	0.600***	-0.00100	1				
lnHospitalLevel_reflect	0.017*	-0.043***	0.028***	1			
CityGDP	0.070***	-0.077***	0.077***	0.0100	1		
lnArticle	0.402***	0.037***	0.601***	0.061***	0.049***	1	
ServiceNum	0.355***	-0.109***	0.327***	0.030***	-0.085***	0.255***	1
lnAveReport	0.672***	-0.122***	0.716***	0.027***	-0.052***	0.452***	0.339***
lnDisclosure	0.164***	0.427***	0.279***	-0.033***	0.0110	0.347***	0.041***
lnTotalGiftRate	-0.177***	0.047***	-0.467***	-0.023**	0.035***	-0.193***	-0.175***
lnReviewRate	-0.266***	0.111***	-0.674***	-0.031***	-0.0110	-0.326***	-0.242***
Recommend	0.654***	0.099***	0.515***	-0.060***	0.132***	0.363***	0.183***
Risk	-0.169***	0.00700	-0.228***	-0.026***	-0.037***	-0.128***	-0.066***
OpenYear	-0.040***	0.343***	0.159***	-0.026***	0.083***	0.219***	-0.083***
	lnAve Report	lnDisco- sure	lnTotal GiftRate	lnReview Rate	Recom- mend	Risk	Open Year
lnAveReport	1						
lnDisclosure	0.128***	1					
lnTotalGiftRate	-0.204***	-0.043***	1				
lnReviewRate	-0.338***	-0.054***	0.804***	1			
Recommend	0.622***	0.276***	-0.052***	-0.136***	1		
Risk	-0.218***	-0.044***	0.081***	0.100***	-0.109***	1	
OpenYear	-0.181***	0.317***	-0.00500	0	0.072***	-0.0120	1

Table 5: Correlations of variables of offline sample.

	lnOffline Patient	Medical Title	lnTotal Patient	lnHospital Level_ reflect	CityGDP	lnArticle	Service Num
lnOfflinePatient	1						
MedicalTitle	0.152***	1					
lnTotalPatient	0.539***	0.072***	1				
lnHospitalLevel_reflect	-0.0230	-0.0140	0.0210	1			
CityGDP	0.157***	-0.055***	-0.099***	0.00400	1		
lnArticle	0.246***	0.063***	0.571***	0.071***	-0.064***	1	
ServiceNum	0.0120	-0.111***	0.317***	0.0120	-0.198***	0.256***	1
lnAveReport	0.436***	-0.126***	0.699***	0.00700	-0.180***	0.410***	0.309***
lnDisclosure	0.218***	0.341***	0.331***	0.0190	-0.037**	0.387***	0.079***
lnTotalGiftRate	-0.091***	0.00400	-0.382***	-0.035**	0.114***	-0.122***	-0.163***
lnReviewRate	-0.172***	0.036**	-0.585***	-0.029*	0.128***	-0.265***	-0.251***
Recommend	0.407***	0.063***	0.540***	-0.035**	0.0220	0.366***	0.167***
lnOnlinePatient	0.383***	-0.032**	0.604***	0.0120	-0.070***	0.371***	0.293***
Risk	-0.184***	-0.046***	-0.225***	-0.00500	0.00400	-0.105***	-0.053***
OpenYear	0.091***	0.361***	0.254***	-0.0200	0.043***	0.251***	-0.0180

	lnAve Report	lnDisclo- sure	lnTotal GiftRate	lnReview Rate	Recom- mend	lnOnline Patient	Risk
lnDisclosure	1						
lnTotalGiftRate	0.137***	1					
lnReviewRate	-0.125***	-0.062***	1				
Recommend	-0.261***	-0.110***	0.820***	1			
lnOnlinePatient	0.652***	0.261***	0.0100	-0.082***	1		
lnAveReport	0.656***	0.154***	-0.153***	-0.235***	0.630***	1	
Risk	-0.209***	-0.056***	0.109***	0.098***	-0.100***	-0.168***	1
OpenYear	-0.169***	0.311***	0.00500	-0.040**	0.072***	-0.038**	-0.0220
	OpenYear						
OpenYear	1						

MODEL AND ANALYSIS

Model Estimation

This study built multiple linear regression models of patients' online and offline medical choice respectively. Considering the moderating effect of disease risk on the relationship between ability trust or honest trust and patients' medical choice, the study firstly centralized disease risk (Risk), physician's medical title (MedicalTitle), physician's patient experience (lnTotalPatient), city economic level (CityGDP), hospital level (lnHospitalLevel_reflect), and information disclosure (lnDisclosure). Centralizing the above variables before multiplying them to derive cross terms aimed to avoid multicollinearity.

To test hypotheses about the direct and moderating effects on patients' medical choice, this study created four empirical models as follows:

$$\begin{aligned} \ln \text{OnlinePatient} = & \alpha_0 + \alpha_1 \text{OpenYear} + \alpha_2 \text{MedicalTitle} + \alpha_3 \ln \text{TotalPatient} + \alpha_4 \ln \text{HospitalLevel_reflect} + \alpha_5 \text{CityGDP} + \alpha_6 \ln \text{Article} \\ & + \alpha_7 \text{ServiceNum} + \alpha_8 \ln \text{AveReport} + \alpha_9 \ln \text{Disclosure} + \alpha_{10} \ln \text{TotalGiftRate} + \alpha_{11} \ln \text{ReviewRate} + \alpha_{12} \text{Recommend} \\ & + \alpha_{13} \text{Risk} + \varepsilon \end{aligned} \quad (1)$$

$$\begin{aligned} \ln \text{OnlinePatient} = & \beta_0 + \beta_1 \text{OpenYear} + \beta_2 \text{MedicalTitle} + \beta_3 \ln \text{TotalPatient} + \beta_4 \ln \text{HospitalLevel_reflect} + \beta_5 \text{CityGDP} + \beta_6 \ln \text{Article} \\ & + \beta_7 \text{ServiceNum} + \beta_8 \ln \text{AveReport} + \beta_9 \ln \text{Disclosure} + \beta_{10} \ln \text{TotalGiftRate} + \beta_{11} \ln \text{ReviewRate} + \beta_{12} \text{Recommend} \\ & + \beta_{13} \text{Risk} + \beta_{14} \text{Risk} \times \text{MedicalTitle} + \beta_{15} \text{Risk} \times \ln \text{TotalPatient} + \beta_{16} \text{Risk} \times \ln \text{HospitalLevel_reflect} \\ & + \beta_{17} \text{Risk} \times \text{CityGDP} + \beta_{18} \text{Risk} \times \ln \text{Disclosure} + \mu \end{aligned} \quad (2)$$

$$\begin{aligned} \ln \text{OfflinePatient} = & \chi_0 + \chi_1 \text{OpenYear} + \chi_2 \text{MedicalTitle} + \chi_3 \ln \text{TotalPatient} + \chi_4 \ln \text{HospitalLevel_reflect} + \chi_5 \text{CityGDP} + \chi_6 \ln \text{Article} \\ & + \chi_7 \text{ServiceNum} + \chi_8 \ln \text{AveReport} + \chi_9 \ln \text{Disclosure} + \chi_{10} \ln \text{TotalGiftRate} + \chi_{11} \ln \text{ReviewRate} + \chi_{12} \text{Recommend} \\ & + \chi_{13} \ln \text{OnlinePatient} + \chi_{14} \text{Risk} + \theta \end{aligned} \quad (3)$$

$$\begin{aligned} \ln \text{OfflinePatient} = & \delta_0 + \delta_1 \text{OpenYear} + \delta_2 \text{MedicalTitle} + \delta_3 \ln \text{TotalPatient} + \delta_4 \ln \text{HospitalLevel_reflect} + \delta_5 \text{CityGDP} + \delta_6 \ln \text{Article} \\ & + \delta_7 \text{ServiceNum} + \delta_8 \ln \text{AveReport} + \delta_9 \ln \text{Disclosure} + \delta_{10} \ln \text{TotalGiftRate} + \delta_{11} \ln \text{ReviewRate} + \delta_{12} \text{Recommend} \\ & + \delta_{13} \ln \text{OnlinePatient} + \delta_{14} \text{Risk} + \delta_{15} \text{Risk} \times \text{MedicalTitle} + \delta_{16} \text{Risk} \times \ln \text{TotalPatient} \\ & + \delta_{17} \text{Risk} \times \ln \text{HospitalLevel_reflect} + \delta_{18} \text{Risk} \times \text{CityGDP} + \delta_{19} \text{Risk} \times \ln \text{Disclosure} + \eta \end{aligned} \quad (4)$$

where $\alpha_0, \beta_0, \chi_0$ and δ_0 are the intercepts. $\alpha_i, \beta_i, \chi_i$ and δ_i are the focus parameters to be estimated. ε, μ, θ and η are the error terms.

The difference between model 3 and model 1 was that the dependent variable was replaced with patients' offline medical choice, while patients' online medical choice was added to the independent variables.

Model 2 and model 4 were added five interaction terms based on model 1 and model 3 respectively.

Results

Multiple regression analysis was performed by Stata software. Table 6 presents the results of the model estimated by conducting multiple regression analysis. We presented this equation hierarchically, first showing a model with independent variables in Column 1, and then introducing interaction terms in Column 2. The adjusted R-square values for the two regression models are 0.586 and 0.420 respectively, meaning that independent variables can explain 58.6% and 42.0% of the patients' online and offline medical choices respectively, which suggests that the models are reasonable designed with high fitting degrees and significant explanatory power.

Table 6: Parameter estimates of patients' online and offline medical choice.

VARIABLES	Patients' online medical choice (lnOnlinePatient)		Patients' offline medical choice (lnOfflinePatient)	
	Model 1	Model 2	Model 3	Model 4
MedicalTitle	-0.022* (-1.75)	-0.025** (-1.97)	0.174*** (9.48)	0.172*** (9.34)
lnTotalPatient	0.138*** (17.46)	0.140*** (17.69)	0.298*** (23.42)	0.299*** (23.45)
lnHospitalLevel_reflect	0.258*** (3.09)	0.248*** (2.91)	-0.201** (-2.02)	-0.201** (-2.02)
CityGDP	0.007*** (4.13)	0.007*** (4.30)	0.038*** (15.54)	0.038*** (15.53)
lnArticle	0.018*** (3.06)	0.018*** (3.08)	-0.046*** (-6.07)	-0.046*** (-5.99)
ServiceNum	0.147*** (20.32)	0.146*** (20.33)	-0.098*** (-8.72)	-0.099*** (-8.80)
lnAveReport	0.216*** (17.92)	0.207*** (17.00)	0.045*** (2.79)	0.040** (2.48)
lnDisclosure	-0.041*** (-3.89)	-0.041*** (-3.95)	0.035** (2.32)	0.037** (2.45)
lnTotalGiftRate	-0.297*** (-6.11)	-0.288*** (-5.92)	-0.029 (-0.28)	-0.041 (-0.40)
lnReviewRate	0.326*** (9.58)	0.315*** (9.23)	0.461*** (6.31)	0.448*** (6.13)
Recommend	1.120*** (42.91)	1.126*** (43.12)	0.078** (2.34)	0.086** (2.56)
lnOnlinePatient			0.014 (1.23)	0.011 (1.01)
Risk	-0.040*** (-2.66)	-0.050*** (-3.30)	-0.063*** (-3.00)	-0.074*** (-3.50)
Risk × MedicalTitle		-0.020 (-0.83)		-0.061* (-1.73)
Risk × lnTotalPatient		-0.047*** (-6.49)		-0.048*** (-3.91)
Risk × lnHospitalLevel_reflect		-0.089 (-0.50)		-0.080 (-0.39)
Risk × CityGDP		-0.003 (-1.02)		-0.005 (-0.94)
Risk × lnArticle		0.039* (1.91)		0.025 (0.88)
OpenYear	Yes	Yes	Yes	Yes
Constant	-4.274*** (-38.13)	-4.273*** (-38.17)	-1.844*** (-11.79)	-1.853*** (-11.86)
Observations	10,931	10,931	4,042	4,042
R-squared	0.587	0.588	0.423	0.426
F test	0	0	0	0
r2_a	0.586	0.587	0.420	0.422
F	594.9	502.2	109.2	93.03

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

According to model 1 in Table 6, though physician's medical title is significant under 5%, the effect is negative ($\beta=-0.022$, $p<0.05$), H1aa is not supported. H1ba ($\beta=0.138$, $p<0.001$) and H1da ($\beta=0.007$, $p<0.001$) are supported. Despite the coefficient of the hospital level ($\beta=0.258$, $p<0.001$) is significant and positive, positive coefficient indicates a negative effect due to data mapping as stated earlier; therefore, H1ca is not supported. As for patients' offline medical choice, the results provided support for hypotheses on ability trust. According to model 3 in Table 6, we found physician's medical title ($\beta=0.174$, $p<0.001$), patient experience ($\beta=0.298$, $p<0.001$), hospital level ($\beta=-0.201$, $p<0.01$), city economic level ($\beta=0.038$, $p<0.001$) significantly and positively affect patients' offline medical choice, among which the influence of physician's patient experience is the largest and the influence of city economic level is the smallest. Four proxies representing ability trust have significant positive effects on patients' offline medical choice, providing support to H1ab, H2bb, H3cb, and H4db.

In the benevolence trust dimension, the coefficients of number of shared articles ($\beta=0.018$, $p<0.001$), number of service types ($\beta=0.147$, $p<0.001$), average monthly reports after hospital visit ($\beta=0.216$, $p<0.001$) are positive and statistically significant. Thus, H2aa, H2ba, H2ca are supported. In terms of offline selection behaviour, the coefficients of three proxies of benevolence trust are significant under 0.1%. But the effects of number of shared articles ($\beta=-0.046$, $p<0.001$) and number of service types ($\beta=-0.098$, $p<0.001$) are negative, which are contrary to the hypotheses; therefore, H2ab and H2bb are rejected. Average monthly reports after hospital visit ($\beta=0.045$, $p<0.001$) is positive and H2cb is supported. Among the proxies representing benevolence trust, average monthly reports after hospital visits promotes patients' offline medical choice, while number of shared articles and number of service types have no positive effect on patients' offline medical choice.

It can be seen that ability trust has a greater positive effect on patients' offline medical choice compared with on patients' online medical choice, contrastingly, benevolence trust has a greater positive effect on patients' online medical choice compared with on patients' offline medical choice.

In the honest trust dimension, in aspect of online behaviour, the effect of information disclosure ($\beta=-0.041$, $p<0.001$) is negative, which is contrary to the hypothesis; therefore, H3a is rejected. Honest trust does not have a positive effect on patients' online medical choice. In aspect of offline behaviour, information disclosure ($\beta=0.035$, $p<0.01$) is positive and statistically significant, so H3b is supported, indicating that honest trust has a significant positive effect on patients' offline medical choice and that information disclosure can reflect physician's honest attitude, which is valued by outpatients when choosing a physician.

The trust transfer theory proposes that potential patients will borrow existing patients' trust in a physician to develop trust. For patients' online medical choice, the effect of virtual gift rate ($\beta=-0.297$, $p<0.001$) is negative, contrary to hypothesis, so H4aa is not supported. Analysis revealed that review rate and recommendation level have positive influence on patients' online medical choice, as evidenced by significant positive coefficients of review rate ($\beta=0.326$, $p<0.001$) and recommendation level ($\beta=1.120$, $p<0.001$). so H4ba and H4ca are supported. For patients' offline medical choice, H4ab is not supported as the coefficient of virtual gift rate is not significant. In contrast, review rate (H4bb) and recommendation level (H4cb) have positive influence on patients' offline medical choice, as evidenced by significant positive coefficients of review rate ($\beta=0.461$, $p<0.001$) and recommendation level ($\beta=0.461$, $p<0.001$).

Patients' online medical choice has no significant effect on patients' offline medical choice; therefore, H5 is not supported. Geographical restriction keeps patients from visiting the same physician in hospital after consulting online. Gap between online and offline channel leads to gap between trust in the two channels so that it is hard for established trust online to transfer between channels and form offline trust.

Hypothesis 6a, 6b, 6c, and 6d test the moderation effects of disease risk on the relationship between ability trust and patient choice. In terms of patients' online medical choice, results show that disease risk significantly and negatively moderates the relationship between physician's patient experience and patient choice ($\beta = -0.047$, $p<0.001$); therefore, H6ba is supported. The positive effect of physician's patient experience on patients' online medical choice is stronger under low disease risk, which indicates that patients with low-risk diseases tend more to choose physicians with high patient experience compared with patients with high-risk diseases. With respect to the other indicators of ability trust, as evidenced by the interaction terms of disease risk with the three proxies, disease risk has no significant moderating effect on physicians' medical title, hospital level, and city economic level; therefore, H6aa, H6ca, H6da are not supported. H6e tests the moderation effect of disease risk on the relationship between honest trust and patient choice. According to model 2 in Table 6, this research found a significant and negative impact of information disclosure on patient choice ($\beta = 0.039$, $p<0.05$), i.e., disease risk has inhibition effect on the relationship between information disclosure and patients' online medical choice, providing support to H6ea. In terms of patients' offline medical choice, disease risk has inhibition effect on the relationship between physician's medical title and medical choice and on the relationship between physician's patient experience and medical choice, as evidenced by interaction term of disease risk and physician's medical title ($\beta=-0.061$, $p<0.05$) and that of disease risk and physician's patient experience ($\beta=-0.048$, $p<0.001$); therefore H6ab and H6bb are supported. For the other indicators of ability trust dimension, the interaction terms of disease risk and city economic level and hospital level have no significant effect on patients' offline medical choice, indicating that there is no significant moderating effect of disease risk on hospital level and city economic level. H6cb and H6db are not supported. In the dimension of honest trust, the interaction term of disease risk and physician's information disclosure also has no significant effect on patients' offline medical choice, indicating that there is no moderating effect of disease risk on information disclosure and H6eb is not supported.

According to adjusted R-square values of models, the explaining power of the model increase when interaction terms added, suggesting that disease risk indeed plays a moderating effect in both patient's online and offline medical choice. Meanwhile, the explaining power of the online model is greater than that of the offline model, suggesting that information presented online has more influence on online medical choice than offline medical choice. Online consultation is unrestricted by transportation, hence the main source of information is the doctor's information presented on the platform. By contrast, limited by their geographical location, outpatients need to take transportation factors into consideration and face more complex information sources such as hospital facilities, inpatient environment, and medical team. As a result, physicians' information presented online only accounts for a small portion of patients' considerations, resulting in less impact of presented information on offline visits than on online consultations.

Overall, 9 of the 16 hypotheses regarding patients' online medical choice are supported, and 10 of the 17 hypotheses regarding patients' offline medical choice are supported. The outcomes of hypothesis test are shown in Table 7.

Table 7: Outcomes of Hypothesis Test

Hypothesis	Relationship	Online	Offline	
Ability trust	H1a	Physician's medical title→Patients' medical choice	Rejected	Supported
	H1b	Physician's patient experience→Patients' medical choice	Supported	Supported
	H1c	Hospital level→Patients' medical choice	Rejected	Supported
	H1d	City economic level→Patients' medical choice	Supported	Supported
Benevolence trust	H2a	Number of shared articles→Patients' medical choice	Supported	Rejected
	H2b	Number of provided services→Patients' medical choice	Supported	Rejected
	H2c	Average monthly number of reports after hospital visit→Patients' medical choice	Supported	Supported
Honest trust	H3	Information disclosure→Patients' medical choice	Rejected	Supported
	H4a	Virtual gift rate→Patients' medical choice	Rejected	Rejected
Trust transfer	H4b	Review rate→Patients' medical choice	Supported	Supported
	H4c	Recommendation level→Patients' medical choice	Supported	Supported
	H5	Patients' online medical choice→Patients' offline medical choice	\	Rejected
Moderating effect of disease risk	H6a	Disease risk×medical title→Patients' medical choice	Rejected	Supported
	H6b	Disease risk×Patient experience→Patients' medical choice	Supported	Supported
	H6c	Disease risk×Hospital level→Patients' medical choice	Rejected	Rejected
	H6d	Disease risk×City economic level→Patients' medical choice	Rejected	Rejected
	H6e	Disease risk×Information disclosure→Patients' medical choice	Supported	Rejected

Robustness Check

In order to check the robustness of the model, we randomly selected 50% from all the data of the online and offline samples respectively into two subsamples referring to the study by Lin (2020), and then conducted regression with the subsamples.

Table 8 presents the results of the multiple linear regression model. The results are consistent with the results using the whole sample. Therefore, the results are robust.

Table 8: Parameter estimates of patients' online and offline medical choice (robust check)

VARIABLES	Patients' online medical choice (lnOnlinePatient)		Patients' offline medical choice (lnOfflinePatient)	
	Model 1	Model 2	Model 3	Model 4
MedicalTitle	-0.020 (-1.11)	-0.025 (-1.37)	0.162*** (6.09)	0.160*** (6.03)
lnTotalPatient	0.133*** (11.77)	0.134*** (11.95)	0.304*** (16.81)	0.304*** (16.79)
lnHospitalLevel_reflect	0.121 (1.04)	0.125 (1.08)	-0.434*** (-2.78)	-0.432*** (-2.77)
CityGDP	0.009*** (3.72)	0.009*** (3.76)	0.039*** (10.85)	0.039*** (10.83)
lnArticle	0.030*** (3.50)	0.031*** (3.61)	-0.046*** (-4.22)	-0.045*** (-4.10)
ServiceNum	0.146*** (14.12)	0.147*** (14.21)	-0.108*** (-6.82)	-0.108*** (-6.86)
lnAveReport	0.229*** (13.51)	0.217*** (12.73)	0.061*** (2.60)	0.057** (2.42)
lnDisclosure	-0.039*** (-2.64)	-0.041*** (-2.74)	0.037* (1.77)	0.040* (1.85)
lnTotalGiftRate	-0.333*** (-4.99)	-0.330*** (-4.96)	0.045 (0.33)	0.045 (0.33)
lnReviewRate	0.349*** (7.22)	0.338*** (7.01)	0.395*** (4.06)	0.386*** (3.96)
Recommend	1.081*** (29.45)	1.087*** (29.61)	0.114** (2.41)	0.119** (2.49)
lnOnlinePatient			0.007 (0.43)	0.006 (0.35)

Risk	-0.074*** (-3.46)	-0.086*** (-4.02)	-0.057* (-1.89)	-0.066** (-2.16)
Risk × MedicalTitle		-0.042 (-1.18)		-0.082 (-1.56)
Risk × lnTotalPatient		-0.062*** (-6.01)		-0.037** (-2.08)
Risk × lnHospitalLevel_reflect		0.185 (0.79)		0.010 (0.03)
Risk × CityGDP		-0.007 (-1.54)		-0.003 (-0.48)
Risk × lnArticle		0.062** (2.18)		0.032 (0.78)
OpenYear	Yes	Yes	Yes	Yes
Constant	-4.128*** (-26.82)	-4.114*** (-26.78)	-1.531*** (-6.50)	-1.559*** (-6.61)
Observations	5,465	5,465	2,021	2,021
R-squared	0.591	0.594	0.459	0.460
F test	0	0	0	0
r2_a	0.589	0.591	0.451	0.452
F	301.7	256.0	62.54	53.02

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

DISCUSSIONS AND IMPLICATIONS

Results and Discussions

In this paper, we investigated the influencing factors of patients' online and offline medical choice in online healthcare community and explored trust transfer from online to offline channel. First, based on the source credibility model and trust transfer theory, we crawled actual business data of *Good Doctor Online* to study the patients' medical choice in Internet medical from the perspective of trust. The research put forward hypotheses and constructed a multiple linear regression model for empirical study, which passed the multicollinearity test, correlation test and robustness check.

The regression results show that the three dimensions of the source credibility model can effectively explain the credibility of trust source and increase patients' trust, thus promote his/her medical choice.

In the dimension of ability trust, physician's medical title, patient experience, hospital level, and economic level where the hospital located all have significant positive effects on patients' offline medical choice, suggesting that these four proxies can serve as good signals of physician's ability, enhance patients' trust and thus promote patients' offline medical choice. The study of Lin (2020) verified the positive effect of physician's medical title and hospital level on patients' offline medical choice, but failed to verify the expansionary effect of city economic level on patients' offline medical choice. Patient experience and city economic level which represent ability trust have significant positive effect on patients' online medical choice. The positive effect of city economic level has been verified by Lin (2020). There is no positive effect of physician's medical title and hospital level, mainly due to the uneven distribution of physicians' medical titles and hospital levels in the online data sample.

In the dimension of benevolence trust, number of shared articles, number of online service types, and average monthly reports after hospital visits all effect on patients' online medical choice significantly and positively, which is consistent with previous studies (Hong, 2020; Lin, 2020; Zeng & Guo, 2018), indicating that if a physician take the initiative to share articles, open more service types, and provide service of report after hospital visits to more outpatients, s/he would appear more friendly and thus persuade patients to consult her/him further. Number of average monthly reports after hospital visits has a significant positive effect on patients' offline medical choice. Number of shared articles has no significant effect on patients' offline medical choice, probably because the function of office appointment is only available on mobile website page where number of shared articles is easily ignored compared with on the online website. The conclusion is inconsistent with that of Lin (2020) and Hong (2020), for changes in page design of the platform over the past two years lead to changes in indicators' ability of attracting users' attention.

Number of service types does not have a significant effect on patients' offline medical choice in this paper, probably because this proxy is less relevant to hospital visits than online consultations. However, Lin (2020) verified the positive effect of number of service types on patients' offline medical choice. In her study, only three service types were available (i.e., consultation with image, consultation through telephone and clinic appointments), hence number of service types ranged between 0 and 3. With the development of the platform in recent years, more types of services have been developed to meet users' individual needs and there have been eight service types at the time this research was completed, that is, number of service types in this study ranges between 0 and 8. Different numeric ranges of the variables lead to different findings of this paper and those of the studies carried out two years ago.

Meanwhile, the positive influence of ability trust on patients' offline medical choice is greater than on online medical choice, while the positive influence of benevolence trust on patients' online medical choice is greater than on offline medical choice.

The reason is that outpatients perceive higher disease risk and value medical skill rather than service experience when choosing a physician; while patients consulting online have higher requirements for service experience out of lack of face-to-face interaction with physicians.

There is a significant positive effect of honest trust on patients' offline medical choice in accordance with the study of Lin (2020), suggesting that patients value physician's honesty in the office appointment process. Conversely, honest trust has no significant influence on patients' online medical choice because outpatients who perceive higher disease risk have more motivation to undertake more cognitive effort to interpret the physician's profile to ensure a right decision; contrastingly, online patients are less cautious about their selection decisions and therefore place less importance on the information disclosed by the physician. This conclusion differs from existing study since different measurements of information disclosure were used. Zeng (2019) measured information disclosure by profile picture, patient experience, professional specialties and clinic information, while this paper measured information disclosure by word count of physicians' specialties and profiles.

The results also validate trust transfer theory, in which potential patients perceive trust in physicians by drawing on other patients' reviews and platform's recommendation level, forming an indirect trust relationship and promoting patients' selection intention. Review rate and recommendation level have significant positive effects on patients' online and offline medical choices, indicating that if more existing users are willing to evaluate the physician after consultation and the platform's recommendation level for the physician is higher, more potential patients will be persuaded to choose that physician, which is consistent with the findings of existing studies (e.g., Zeng, 2019). Virtual gift rate has no significant effect on patients' medical choice both online and offline, consistent with the study by Deng et al. (2019).

Trust transfer from online to offline channel is not validated in this study. Patients' online medical choice had no positive effect on patients' offline medical choice. Geographical limitation leads to gap between channels that established trust online hardly transfer between channels and form offline trust. However, Hong (2020) tested patient trust transfer from online to offline channel by multiple linear regression using total number of online consultations and offline appointments to measure patients' trust online and offline respectively and came to the conclusion that patients' online trust had a significant positive effect on patient offline trust. However, total number of online consultations and offline appointments are directly related to the opening time of physicians' homepages and whether they can serve as good indicators of patient trust is doubtful. Different variable selections in the two models lead to differences in the findings.

This paper introduced the moderating effect into the field of online healthcare to investigate the moderating effect of disease risk on the influence of ability trust and honest trust. In terms of patients' online medical choice, disease risk weakens the positive effect on relationship between physician's patient experience and patients' online medical choice. It is because patients consulted online can be divided into undiagnosed ones and diagnosed ones whose medical choice tendency differs and the proportion of undiagnosed patients in low-risk disease group is higher than in high-risk disease group. Patients with low-risk diseases tend more to choose physicians online by checking physician's information presented on the website, while patients with high-risk diseases tend more to choose physicians through report after hospital visit or by directly searching and finding physicians who they have already consulted.

There is no significant moderating effect of disease risk on the relationship between the other indicators of ability trust dimension (i.e., physician's medical title, city economic level, and hospital level) and patients' online medical choice. This is because there are two types of online patients (undiagnosed patients and diagnosed patients) and patients' receive undifferentiated information of physicians' medical titles and hospital levels. In contrast, the findings of Zeng and Guo (2018) suggested that disease risk positively moderates the effect of physician's medical title. Their study standardized medical title and academic title to obtain an indicator of physician's title, while this paper only considered medical title, leading to the difference in findings.

Disease risk also weakens the negative effect on the relationship between honest trust and patients' online medical choice. When consulting online, patients with high disease risk place more importance on their health status and are more motivated to find an honest physician. In contrast, Zeng and Guo (2018) suggested no moderating effect of disease risk on the influence of information disclosure, and the difference between findings in the two studies probably due to different measurement of the degree of disclosure.

In aspect of patients' offline medical choice, disease risk weakens the influence on the relationship between physician's medical title and patients' offline medical choice and on the relationship between physician's patient experience and patients' offline medical choice. When physician has high medical title or is experienced, selection intention of patients with low-risk disease is higher than that of patients with high-risk disease, due to the difficulty of making office appointment and limited number of hospital places. There is no significant moderating effect of disease risk on the relationship between other indicators of the ability trust dimension (i.e., city economic level and hospital level) and information disclosure which represents the honest trust dimension and patients' online medical choice. The reason is that patients in need of hospital visits consider more complex factors such as hospital facilities, inpatient environment and medical team, which reduces influence of information presented on physician's homepage and leads to less explanatory power of online information on hospital visits than on online consultations.

Theoretical Implications

The theoretical contributions of this paper are threefold.

First, there are a few scholars who have conducted studies on physician-patient trust in online healthcare communities from different areas and perspectives. However, in the physician-patient trust relationship, physicians not only play a passive role

being trusted by patients, but can also take active behaviours to win patients' trust. This paper enriches the research on physician-patient trust from the perspective of the trustee and provides feasible suggestions for physicians to enhance patients' trust. Prior studies often excessively focus on patients consulting online in healthcare, ignoring patients who make appointments through online healthcare platforms and visit in hospital. This paper takes the two types of patients (i.e., patients making online consultation and office appointment) into account, giving due attention to the growing group of offline patients in the Internet medical field.

Next, most of the studies on physician-patient trust through questionnaire survey and interviews for qualitative analysis. The research established regression models of patients' online medical choice and patients' offline medical choice respectively and crawled actual business data in the online healthcare community, of which conclusions are more objective and precise.

Finally, existing trust transfer research most concern with trust transfer between channels and focus primarily on the transfer from offline channel to online channel, and here has been very little research exploring trust transfer from online channel to offline channel. Trust transfer in the health field remains under-explored. This paper explores the trust transfer from online to offline channel, which contributes to the body of research on trust transfer in the field of Internet medical and the integration of online and offline healthcare service resources.

Practical Implications

This study has significant practical implications. Based on the results of the empirical study, feasible suggestions can be given to physicians, patients, and platform builders in online healthcare communities.

Advice for physicians

The results of the study suggest that number of articles published by physicians, number of provided service types and number of reports after hospital visits positively effect on patients' medical choice, and the positive effect on patients' online medical choice is greater than that on patients' offline medical choice. Therefore, physicians can publish more articles such as medical guide and disease related knowledge sharing in their public accounts, and provide more service types to satisfy patients' different needs. Physicians can also provide outpatients with privilege of report after hospital visits. The above actions convey the friendliness of physicians to patients and thus enhance patients' trust and optimize physician-patient interaction.

Information disclosure of physicians will promote patients' offline medical choice. Physicians can improve their personal information presented in online healthcare community, such as professional specialties and good wishes, to convey their sincerity to patients.

It is shown that patients prefer physicians with high medical competence and that disease risk moderates patients' selection behaviour. Therefore, it is recommended that physicians need to pay attention to both medical skills and disease types and risks they treat. In addition, hospital administrators should urge physicians to improve both their medical skills and service attitudes, for example, by incorporating medical skills and service attitudes into performance appraisal system.

Advice for patients

When choosing a physician, patients can evaluate the physician's medical ability by physician's medical title, patient experience and hospital level; evaluate the physician's friendliness by number of articles published by the physician, number of provided service types and number of reports after hospital visits; they can evaluate the physician's honesty by the physician's information disclosure such as profile and professional expertise to get a better understanding of the physician's actual situation. Patients can also draw on trust of existing patients in the physician according to review rate of existing patients as well as the platform's recommendation level to judge whether the physician is trustworthy.

Advice for medical platform builders

This study contributes to the design and improvement of online healthcare communities enabling the platform to provide better services to patients and physicians. First, there are various degrees of influence of different information on users' decisions, and elements are scattered on different pages. The platform builder can gather the decision information which users are concerned about and give visual priority to the key information to make it convenient for users to view, thus help patients process relevant information in a better way and save their time and energy for decision making. Next, it is found that due to geographical restrictions, patients may not be able to visit the same physician in hospital after online consultation, resulting in the trust accumulated online cannot be transferred to offline environment. Platform builders can prioritize local physicians according to the user's location, or remind the user of the physician's location when s/he is choosing a physician online, making it possible for trust to transfer between channels and hence better building physician-patient trust. Again, the results of the study show that reviews of existing patients can facilitate potential patients' choice of physicians. However, many patients are not willing to evaluate the physician after consultation. The platform can encourage users to make reviews by issuing points, establishing user ratings and giving corresponding discounts referring to e-commerce platforms to make full use of trust transfer mechanism. Last, the platform can introduce data mining and artificial intelligence technology to accurately match physicians and patients online, which can reduce users' cognitive effort of medical selection and improve its accuracy, hence avoid waste of time and energy of both physicians and patients.

Limitations and Future Research Directions

There are some limitations in the research which can be further expanded in future studies.

First, this paper used data from only one online healthcare platform, which may reduce the generalizability of the findings due to differences in platform environment and user group characteristics of different platforms. It is necessary to collect data from several platforms to conduct comparative studies.

Second, this paper only conducted a cross-sectional analysis and lacked information about how any changes to the physicians' information might affect patients' choices. Future studies could use panel data to investigate the dynamic effects of information on patients' choices.

Third, factors to consider are more complex when choosing a physician offline than online. Future study can include hardware facilities and medical team in the model to gain a better understanding of the influencing factors of outpatients' medical choice. Further, there are three modes of making appointment on *Good Doctor Online*, two of which are newly-developing. Future research could explore the differences between the emerging modes of appointment and the traditional mode, as well as the influencing factors of patients' medical choice under different modes of appointment.

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Factors influencing the satisfaction of chat commerce usage experience in Thailand: A Covid necessitated e-business platform

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ABSTRACT

It is an undoubted fact that Internet, and by extension, e-commerce on the Internet is here to stay. Merchants of all types, big and small, are aiming to find their niche in the e-commerce marketplace, and increase their revenue. Consumer preferences on online shopping and use of new technologies are continually shifting as well. Expansion of e-commerce offerings has significantly increased the number of users and trading volumes of online shopping, therefore highlighting the need to research online consumer purchasing behavior. In the meantime, COVID-19, which forced public lockdowns over the last 2 years, led the consumers to engage in alternative purchasing channels. One of those new channels that was successful due to the increased use of smartphone mobile apps technology is called "conversation commerce", a.k.a., "chat commerce" or "c-commerce".

In this research, with the use of a web-based survey involving 227 respondents, we investigated into the factors influencing the satisfaction of chat commerce usage experience in Thailand, and focused on their views based on generational age differences among them. This research's objectives were to answer the following 2 research questions: [1] What factors influence the satisfaction of chat commerce usage experience in Thailand?; [2] Do factors influencing the satisfaction of chat commerce usage experience vary among generational age differences?

The 10 factors studied in this research, which may lead to the success of chat commerce in Thailand, were: [1] Service Rep's Reliability; [2] Service Rep's Assurance; [3] Service Rep's Responsiveness; [4] Service Rep's Empathy; [5] Perceived Information Quality; [6] Perceived Appropriate Wait Time; [7] Trust in the Platform; [8] Perceived Ease of Use; [9] Perceived Usefulness; [10] Satisfaction with the Experience.

The 4 generations in this study were: [1] Baby Boomer; [2] Gen X; [3] Gen Y; [4] Gen Z.

The results of this study indicate that all 10 proposed factors ultimately have positive influence on Satisfaction with chat commerce usage experience, and may lead to the success of chat commerce in Thailand, while the 2 most important factors being Assurance [ASS] and Perceived Usefulness [PUS]. This was true for ASS for 3 of the generations (Baby Boomer, Gen X, Gen Z), as well as for the entire dataset; and for PUS for 2 of the generations (Gen Y, Gen Z), as well as the entire dataset.

Keywords: Chat Commerce, Live Chat Interaction, Online Customer Support, Perceived Ease of Use, Perceived Usefulness, Trust in E-Commerce.

INTRODUCTION

The COVID-19 pandemic during Mar/2020–Mar/2022, resulted in public lockdowns and business closures all around the world. Without exception, there were a lot of business management troubles in Thailand as well. In order to survive, those businesses that lost many customers during the lockdowns had to find new channels to reach to their customers. One of those new channels that was successful due to the increased use of smartphone mobile apps technology is called "conversation commerce", a.k.a., "chat commerce" or "c-commerce". During the COVID lockdowns and re-opening periods, instead of leaving their homes to venture outside, general public found it more convenient to communicate and perform purchasing with their favorite merchants using chat commerce platforms with the help of with their smartphone mobile apps right from their homes.

In this research, we aimed to study the factors that may influence the satisfaction of chat commerce usage experience in Thailand, and whether those factors vary among generational age differences.

LITERATURE REVIEW

Chat Commerce

In Wikipedia, “chat commerce” (or “conversational commerce” or “e-commerce”) is defined as follows:

Conversational commerce is e-commerce done via various means of conversation (e.g., live support on e-commerce Web sites, online chat using messaging apps, chatbots on messaging apps or websites, voice assistants), and using technology, such as, speech recognition, speaker recognition (i.e., voice biometrics), natural language processing and artificial intelligence.

According to Reul (2022), the primary goals of conversational commerce are:

- Ensuring that the customer feels as though they are properly guided or assisted during product selection, purchase decision, and order placement.
- Moving the customer through the purchasing process, and reminding them with notifications via direct messages.
- Introducing the customer to products they were otherwise unaware of.
- Providing additional support and recommendations to the customer after the purchase has been completed.

In this research, we scoped chat commerce, which is a means of communication between customers (buyers) and merchants (sellers) for conducting a product purchasing transaction, as follows:

- Using smartphone or tablet/pad;
- Using smartphone or tablet/pad based mobile messaging app (excluding PCs or browsers on merchant websites, or chat features on websites);
- Chatting with a human seller or product Service Rep (excluding chatbots and voice assistants using speech recognition or natural language processing or artificial intelligence, or messenger/delivery driver);
- Chatting via text, emoticons, emojis, stickers, or photo and video attachments (excluding in-person voice/audio/video talking); and
- Using the online chat commerce platform via its e-commerce features (product list, product selection, quantity setting, shopping cart, payment methods, order tracking) within the mobile chat app (excluding person-to-person transactions, which is buying/selling as individuals on their own, without the involvement of a chat commerce platform).

Consequently, the following list of common chat apps that have implemented chat commerce features would fit to the scope of chat commerce platform defined above:

- LINE (as in “LINE Official”)
- Facebook Messenger
- WhatsApp
- Instagram
- WeChat
- Telegram
- Shopee
- Lazada
- Shopify
- and, other similar apps.

Chat commerce, as an e-commerce channel, provides customers a convenient platform for purchasing, and provides merchants a natural way of online marketing. Merchants can use chat commerce for interacting with their customers directly in a remote and digital way, without the customers needing to physically visit the merchant’s store. Moreover, due to its remote and digital way, chat commerce can save customers time and money (Piyush *et al.*, 2016).

Chat Commerce in Thailand

The use of smartphones is increasing all around the world, including Thailand. According to Statista.com (2021a), Thailand ranked 13th in the world in the smartphone penetration rate with 59.3% of the population (as of Mar/2022). In 2019, Facebook was the most prominent social media platform in Thailand with more than 50 million users (Statista.com, 2021b), and LINE Thailand Head of E-commerce stated that they have 47 million users in Thailand (Spring News, 2021). In addition, in 2021, the most preferred platform for online shopping in Thailand was Shopee, which amounted to around 75.6% of users (Statista.com, 2021b). This means that e-commerce through smartphone technology and Internet access brings increased business opportunities.

According to Peck (2020), between 2015 and 2019, the e-commerce gross merchandise volume (GMV) in Thailand increased from 0.9 billion USD to 5 billion USD, as published in the “e-Conomy SEA 2019” report by Google, Bain & Temasek (Davis *et al.*, 2019); that is more than 5x growth in 5 years. In their report, J.P. Morgan (2019) stated that the online shopping sector in Thailand is valued at 26.2 billion USD, of which 13.6 billion USD are transactions completed on mobile devices, and of which 8.9 billion USD are in-app transactions (i.e., using dedicated apps, like LINE, Facebook, WhatsApp, as opposed to common Internet browsers).

In general, Thai people are “chatty” among family and friends, but in person (face-to-face), they have a shy nature towards “strangers” (Srisai, 2011; Chaisiri, 2016). However, in online interactions, because of its perceived remote nature, they seem to overcome their shyness in talking to strangers (Sangiamchit, 2017). Therefore, this makes chat commerce a convenient

platform for their online shopping activities, especially when they have the need to inquire deeper from “strangers” about the products they would like to purchase.

Factors Influencing the Satisfaction of Chat Commerce Usage Experience

Customers develop attitudes and behavioral approaches based on their interaction experience during their service encounter (Verhoef *et al.*, 2009). Customer experience is a holistic process made up from the customer journey, deriving from the sequence of touchpoints a customer has with a service provider (Voss *et al.*, 2008). Recent research studies have focused on customers’ perceptions of websites and the overall service quality, introducing E-S-QUAL (Parasuraman *et al.*, 2005). A comprehensive review of the literature from over the past 20 years, including E-SERVQUAL and WebQual, reveals various factors with a potential to influence the online customer experience. Factors, such as website’s look-&-feel, color coordination, information quality, trust in the platform, ease of use, usefulness, responsiveness, wait time and page navigation, have been outlined by many studies as influencing the online customer experience (Zeithaml *et al.*, 2000; Yoo *et al.*, 2001; Loiacono *et al.*, 2002; Rattanawicha *et al.*, 2003a; Rattanawicha *et al.*, 2003b; Yang *et al.*, 2003; Rattanawicha *et al.*, 2004; Kim *et al.*, 2006; Loiacono *et al.*, 2007; Rattanawicha *et al.*, 2008; Rose *et al.*, 2012; Kalia, 2013; Martin *et al.*, 2015; McLean *et al.*, 2016; McLean *et al.*, 2017).

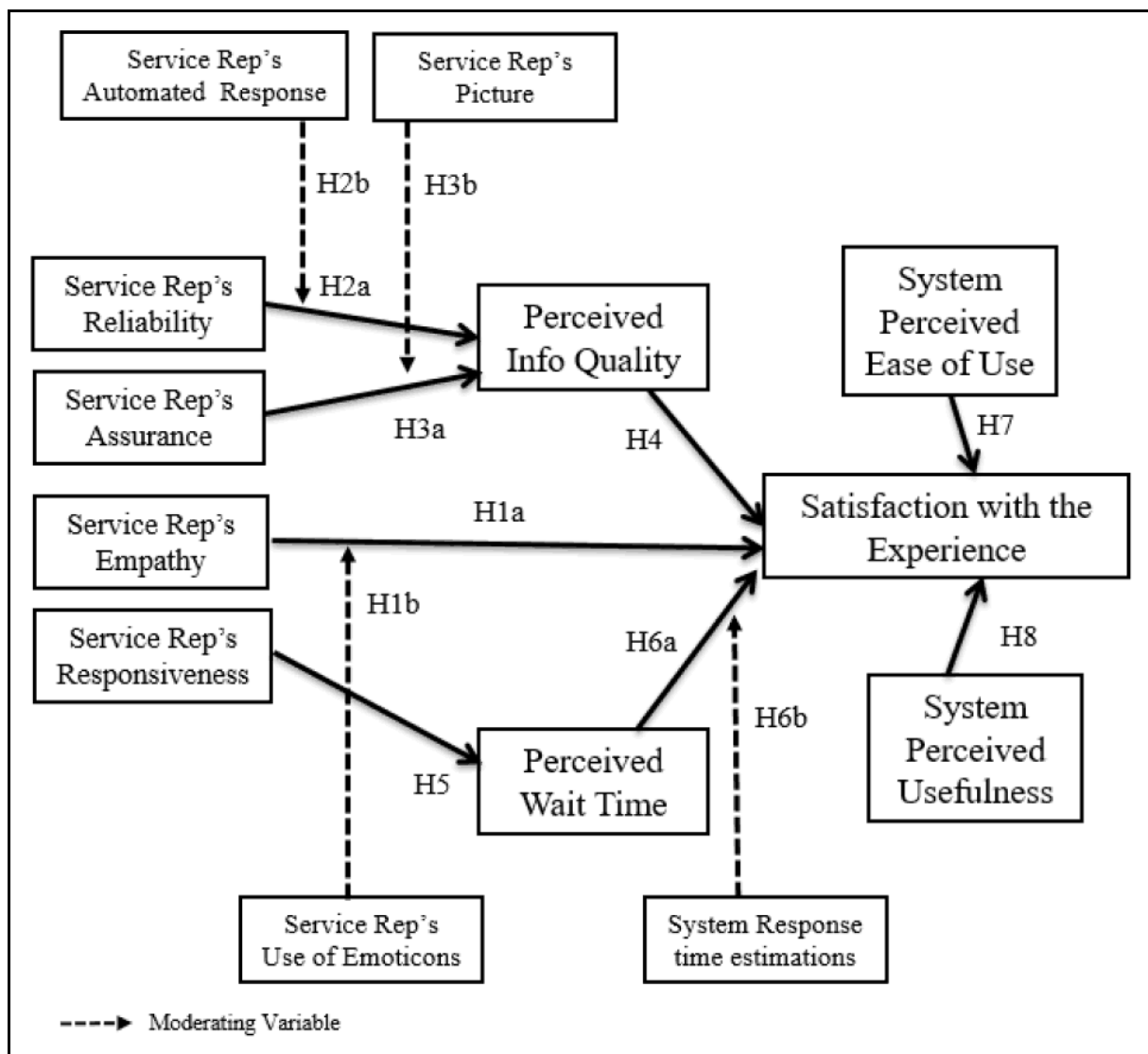


Figure 1: McLean *et al.*'s graphical representation of hypothesized model (2017).

Specifically, for this study, we adopted a slightly modified version of McLean *et al.*'s Technology Acceptance Model (TAM) (McLean *et al.*, 2017), as displayed in Figure 1 above, by integrating “Trust” factor from Rattanawicha *et al.*'s (2003a) as “Trust in the Platform” in our 10 factors.

Main differences between McLean *et al.*'s model and our model are described in Table 1 below.

Table 1: Main differences between McLean *et al.*'s (2017) study and our study.

Item	McLean <i>et al.</i> 's Model	Our Model
[1]	Does <u>not</u> have "Trust in the Platform" as a factor.	Has "Trust in the Platform" as a new factor.
[2]	Service Rep's Empathy (1a) and Perceived Information Quality (H4) and Perceived Wait Time (H6a) influence Satisfaction with the Experience.	Service Rep's Empathy (H4) and Perceived Information Quality (H5) and Perceived Appropriate Wait Time (H6) influence Trust in the Platform.
[3]	Service Rep's Empathy (1a) and Perceived Information Quality (H4) and Perceived Wait Time (H6a) influence Satisfaction with the Experience.	Trust in Platform (H7) influences Satisfaction with the Experience.
[4]	Does <u>not</u> study generational age differences.	Studies generational age differences.
[5]	Studies chat commerce usage experience in United Kingdom.	Studies chat commerce usage experience in Thailand.

The definitions of the 10 factors are as follows:

According to McLean *et al.* (2017), service quality manifests itself in Service Rep's reliability, assurance, responsiveness, and empathy, which also form the first 4 factors of our model, are important indicators in assessing the quality of the received service.

[1] Service Rep's Reliability [REL]

As a part of service quality, Reliability refers to the consistency of performance and dependability of the Service Rep (McLean *et al.*, 2017).

[2] Service Rep's Assurance [ASS]

As a part of service quality, Assurance involves competence, courtesy, credibility, and security offered by the Service Rep (McLean *et al.*, 2017).

[3] Service Rep's Responsiveness [RES]

As a part of service quality, Responsiveness refers to the willingness and readiness of the Service Rep to provide the service in a timely manner (McLean *et al.*, 2017).

[4] Service Rep's Empathy [EMP]

As a part of service quality, Empathy refers to the Service Rep's ability to understand and connect with a customer's feelings for effective communication (McLean *et al.*, 2017).

[5] Perceived Information Quality [PIQ]

DeLone and McLean's Information System Success Model (DeLone and McLean, 2003) outlines information quality as a vital component to an information systems success. An important purpose of a live chat Service Rep is to provide information relevant to the customer's query (Turel *et al.*, 2013; Rattanawicha, 2013). Information that is clear, current, relevant, accurate, complete, and reliable is perceived to be of high quality (Guo *et al.*, 2012). Due to the abundance of information on online platforms, buyers often seek clarification or further information through other confirming sources, such as Service Reps, friends or family (Metzger *et al.*, 2013). Individuals often make evaluations on the quality of information provided; however, this can be challenging for those who are not experts within the topic area (Lucassen *et al.*, 2013). To overcome this, live chat facilities provide customers with an online form of prompt support that allows customers to clarify information (Chattaraman *et al.*, 2012).

[6] Perceived Appropriate Wait Time [PWT]

Wait time is often deemed as secondary to the core service experience; however, studies show that it is often the first touchpoint in the sequence of experiences that customers have with an organization, and a critical part of service quality (Chase *et al.*, 2001). Customers expect Service Reps to be responsive and willing to help in a timely manner (Verhoef *et al.*, 2009). Waiting for service is an experience that can lead to dissatisfied customers (Katz *et al.*, 1991). Customers often overestimate their potential waiting time (Katz *et al.*, 1991; Pruyn *et al.*, 1998), as such these estimated wait times have a significant effect on satisfaction than actual waiting time (Katz *et al.*, 1991; Davis *et al.*, 1998). Thus, as perceived appropriate wait time increases, individual's reactions can become increasingly negative (Folkes *et al.*, 1987; Hui *et al.*, 1998), therefore, resulting in dissatisfactory customer experience (Clemmer *et al.*, 1989; Antonides *et al.*, 2002).

[7] Trust in the Platform [TIP]

In Webster's Dictionary, trust is defined as assured reliance on the character, ability, strength, or truth of someone or something. Trust in the Platform can be viewed from several dimensions such as transaction, presentation, product, service, and technology. Trust in the Platform can be developed and maintained (Elmorshidy *et al.*, 2015). Many studies concluded that trust is one of the most influential factors for customers to conduct commerce online (Gefen *et al.*, 2003; Rattanawicha *et al.*, 2003a).

[8] Perceived Ease of Use [PEU]

Perceived ease of use refers to the degree to which a prospective user expects the target system to be free of effort (Elmorshidy *et al.*, 2015). Most studies on TAM (Davis, 1989) indicate that perceived ease of use directly influences use and intention to use (Rattanawicha *et al.*, 2005).

[9] Perceived Usefulness [PUS]

As another factor in TAM (Davis, 1989), perceived usefulness refers to perceived benefits of using a specific application system. Perceived usefulness has consistently been a strong determination of the intention to use technology (Elmorshidy *et al.*, 2015).

[10] Satisfaction with the Experience [SAT]

Ultimately, resulting from the positive interaction with quality service, quality system and quality information, the customer would be positively influenced and would have a satisfactory experience with the service he/she received from the online merchant. Studies indicate that the factors used in this research that have their roots in the original TAM (Davis, 1989) have a direct impact on customer satisfaction (Rose *et al.*, 2012).

RESEARCH QUESTION AND HYPOTHESES

This research’s objectives were to answer the following 2 research questions:

- 1) What factors influence the satisfaction of chat commerce usage experience in Thailand?
- 2) Do factors influencing the satisfaction of chat commerce usage experience vary among generational age differences?

The 10 factors studied in this research, which may lead to the success of chat commerce in Thailand, were:

- (1) Service Rep’s Reliability [REL]
- (2) Service Rep’s Assurance [ASS]
- (3) Service Rep’s Responsiveness [RES]
- (4) Service Rep’s Empathy [EMP]
- (5) Perceived Information Quality [PIQ]
- (6) Perceived Appropriate Wait Time [PWT]
- (7) Trust in the Platform [TIP]
- (8) Perceived Ease of Use [PEU]
- (9) Perceived Usefulness [PUS]
- (10) Satisfaction with the Experience [SAT]

The 4 generations in this study, as defined in Kotler *et al.* (2021), were:

- (1) Baby Boomer (born in 1946-1964)
- (2) Gen X (born in 1965-1980)
- (3) Gen Y (born in 1981-1996)
- (4) Gen Z (born in 1997-2009)

Figure 2 below outlines our research model and hypotheses relationships.

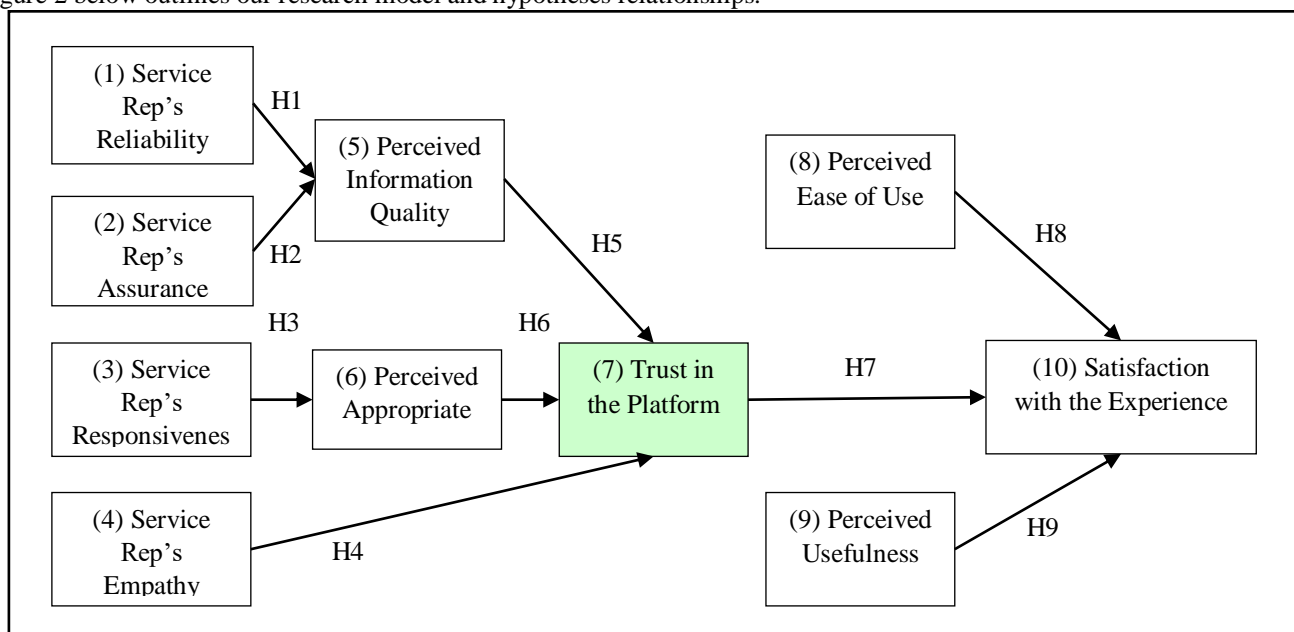


Figure 2: This study’s research model and hypotheses relationships by integrating Rattanawicha *et al.*’s (2003a) “Trust in the Platform” into McLean *et al.*’s (2017) research model.

The objective of this research is to study 10 factors which may lead to the success of chat commerce in Thailand by focusing on the differences of these factors between generations. The four generations in this study are: [1] Baby Boomer; [2] Gen X; [3] Gen Y; and [4] Gen Z. The 10 factors include [1] Service Rep's Reliability; [2] Service Rep's Assurance; [3] Service Rep's Responsiveness; [4] Service Rep's Empathy; [5] Perceived Information Quality; [6] Perceived Appropriate Wait Time; [7] Trust in the Platform; [8] Perceived Ease of Use; [9] Perceived Usefulness; [10] Satisfaction with the Experience. We tested the following hypotheses:

- *H1: Service Rep's Reliability has positive influence on Perceived Information Quality.*
- *H2: Service Rep's Assurance has positive influence on Perceived Information Quality.*
- *H3: Service Rep's Responsiveness has positive influence on Perceived Appropriate Wait Time.*
- *H4: Service Rep's Empathy has positive influence on Trust in the Platform.*
- *H5: Perceived Information Quality has positive influence on Trust in the Platform.*
- *H6: Perceived Appropriate Wait Time has positive influence on Trust in the Platform.*
- *H7: Trust in the Platform has positive influence on Satisfaction with the Experience.*
- *H8: Perceived Ease of Use has positive influence on Satisfaction with the Experience.*
- *H9: Perceived Usefulness has positive influence on Satisfaction with the Experience.*

In addition, above mentioned 9 hypotheses (H1–H9) were again tested for each of the 4 generations as shown below (H10–H18). This was performed for the purpose of analyzing the differences among the 4 generations of respondents. In other words, hypotheses H10–H18 were tested for Baby Boomer generation as follows:

- *H10: Service Rep's Reliability has positive influence on Perceived Information Quality for Baby Boomer customers.*
- *H11: Service Rep's Assurance has positive influence on Perceived Information Quality for Baby Boomer generation.*
- *H12: Service Rep's Responsiveness has positive influence on Perceived Appropriate Wait Time for Baby Boomer generation.*
- *H13: Service Rep's Empathy has positive influence on Trust in the Platform for Baby Boomer generation.*
- *H14: Perceived Information Quality has positive influence on Trust in the Platform for Baby Boomer generation.*
- *H15: Perceived Appropriate Wait Time has positive influence on Trust in the Platform for Baby Boomer generation.*
- *H16: Trust in the Platform has positive influence on Satisfaction with the Experience for Baby Boomer generation.*
- *H17: Perceived Ease of Use has positive influence on Satisfaction with the Experience. for Baby Boomer generation.*
- *H18: Perceived Usefulness has positive influence on Satisfaction with the Experience for Baby Boomer generation.*

Similarly, Hypotheses H19–H27 were tested for Gen X generation, Hypotheses H28–H36 were tested for Gen Y generation, and Hypotheses H37–H45 were tested for Gen Z generation.

RESEARCH METHODOLOGY

Research Tools

An online questionnaire, using Google Forms, was used in order to capture the data required to test the hypothesized correlations. Data was collected from respondents in Thailand who have used chat commerce platforms with their smartphone or tablet/pad apps to purchase products, using texting/emoticons, as well as photo/video attachments (without in-person voice/audio/video interaction) within the last 1 year.

Questionnaire Development

A total of 38 question items to measure the 10 factors were prepared in English, and the questionnaire was backward translated (i.e., translating the questions from English to Thai, and again from Thai to English, comparing both versions, and resolving the identified discrepancies), in order to ensure consistency between the translated Thai and the original English versions. After finalizing the questions content in English and Thai, the questionnaire was prepared in Google Forms format, with the number of questions (i.e., attributes) per factor as shown in Table 2 below.

Table 2: Number of Attributes per Factor.

Factor #	Factor Name	Factor Abbreviation	Number of Attributes
(1)	Service Rep's Reliability	REL	3
(2)	Service Rep's Assurance	ASS	4
(3)	Service Rep's Responsiveness	RES	5
(4)	Service Rep's Empathy	EMP	4
(5)	Perceived Information Quality	PIQ	4
(6)	Perceived Appropriate Wait Time	PWT	3
(7)	Trust in the Platform	TIP	4
(8)	Perceived Ease of Use	PEU	3
(9)	Perceived Usefulness	PUS	5
(10)	Satisfaction with the Experience	SAT	3
		Total:	38

The questionnaire was first tested in a pilot study with 22 respondents, which had 4 male and 18 female respondents, and 2 Baby Boomer, 7 Gen X, 7 Gen Y, and 6 Gen Z respondents. After adjusting wording of some of the questions, the final English and Thai versions of the questionnaire were deployed for the actual data collection. It had 3 parts.

- Part-1 — Definition of Chat Commerce
- Part-2 — Demographics
- Part-3 — Opinions on Chat Commerce Usage Experience

Part-1 — Definition of Chat Commerce

The first part gave definition and examples of chat commerce, with sample screenshots from a typical chat commerce transaction.

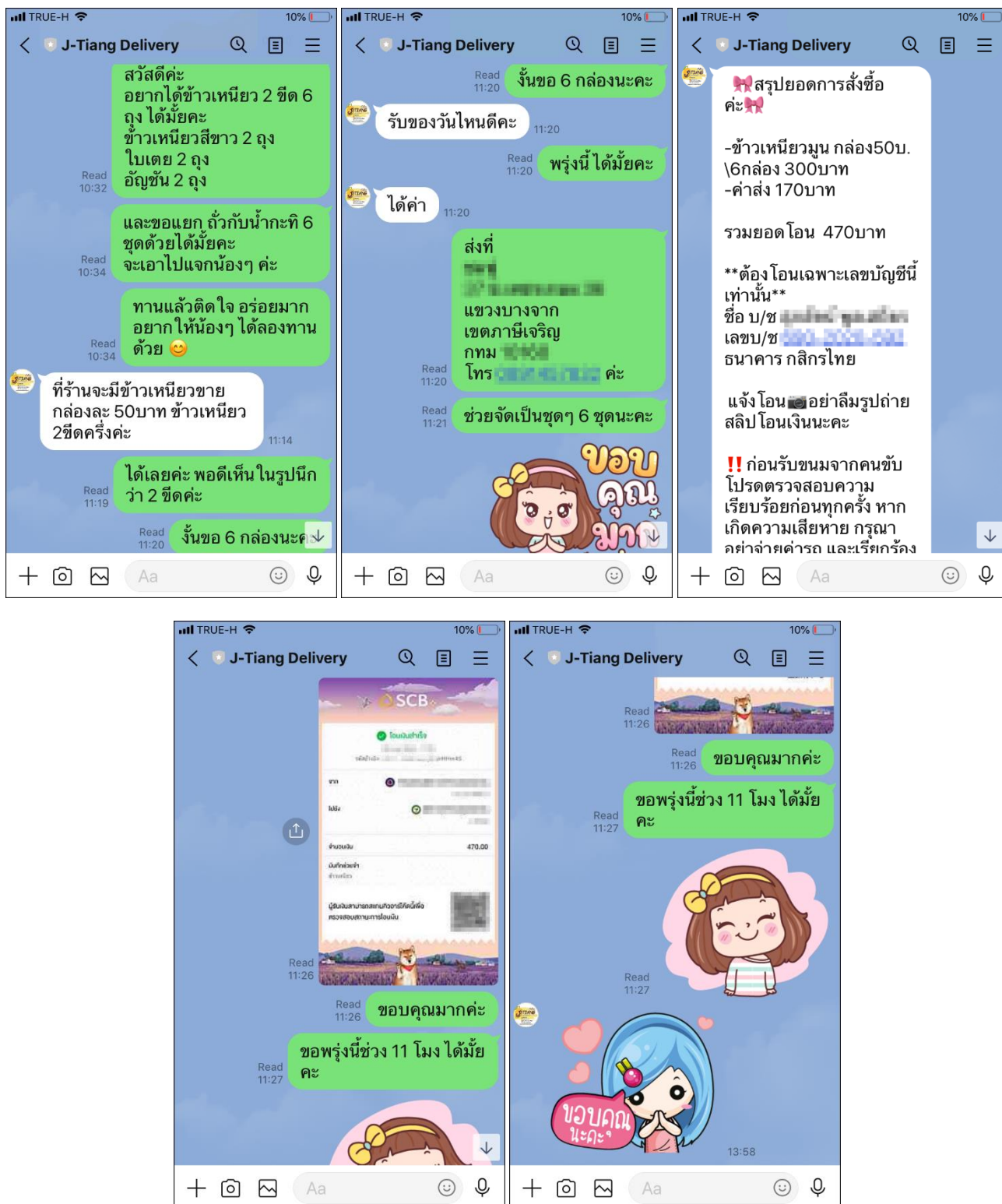


Figure 3: Sample screenshots from a typical chat commerce transaction.

Part-2 — Demographics

The second part collected demographic data, including respondent's year range of birth, gender, experiences with online shopping and chat commerce.

Part-3 — Opinions on Chat Commerce Usage Experience

In the third part, respondents were asked to rate their opinions on the above mentioned 10 factors. Each factor had its own list of attributes (i.e., questions), ranging from 3 to 5 questions. These 10 factors and their related attributes were adapted from previous relevant research with minor adjustments. Ratings for each question ranged from “[5] Strongly agree” to “[1] Strongly disagree”, while rating “[3] Neutral” being the middle rating (a.k.a., Likert scale). Table 3 below presents the wording of the questions, as adapted from various previous studies, that were be used in the final questionnaire.

Table 3: Wording of the factors and the questions (i.e., attributes) used in the final questionnaire.

Factor #	Factor	Q#	Question
(1)	Service Rep's Reliability	REL1 REL2 REL3	When the Service Rep promised to do something, he/she did so. When I have a problem, the Service Rep showed a sincere interest in solving it. The Service Rep performed the service correctly on the first time.
(2)	Service Rep's Assurance	ASS1 ASS2 ASS3 ASS4	I felt certain that the Service Rep understood me clearly in our discussion. The Service Rep had the knowledge to answer my questions. The Service Rep was consistently kind and polite to me. The behavior of the Service Rep gave me confidence.
(3)	Service Rep's Responsiveness	RES1 RES2 RES3 RES4 RES5	The Service Rep was available at convenient business hours. The Service Rep provided prompt service. The Service Rep told me exactly when he/she will perform the service. The Service Rep was always willing to help me. The Service Rep was never too busy to respond to my requests.
(4)	Service Rep's Empathy	EMP1 EMP2 EMP3 EMP4	The Service Rep gave me close attention. The Service Rep was patient with my requests. The Service Rep understood my special needs. The Service Rep had my interests as his/her priority.
(5)	Perceived Information Quality	PIQ1 PIQ2 PIQ3 PIQ4	The information provided by the Service Rep was current and up-to-date. The information provided by the Service Rep was complete and comprehensive. The information provided by the Service Rep was relevant and accurate. The information provided by the Service Rep was easily understandable.
(6)	Perceived Appropriate Wait Time	PWT1 PWT2 PWT3	I waited an appropriate length of time for my various requests during the chat commerce session. The overall length of time I waited during the chat commerce session was acceptable. Chat commerce session took the length of time I expected.
(7)	Trust in the Platform	TIP1 TIP2 TIP3 TIP4	Technology that supports chat commerce was available whenever I wanted to use it. Technology that supports chat commerce was reliable. Technology that supports chat commerce was safe and secure. Overall, I have confidence in the technology that supports the chat commerce.
(8)	Perceived Ease of Use	PEU1 PEU2 PEU3	It was easy to learn and understand the chat commerce. It was easy to perform the necessary steps in the chat commerce. It was easy to become skillful at using the chat commerce.
(9)	Perceived Usefulness	PUS1 PUS2 PUS3 PUS4 PUS5	Chat commerce helped me to get the information I needed about the products and the purchase process. I could use chat commerce to inquire about discounts or promotions. I could use chat commerce for agreeing on payment and delivery of purchased products. Chat commerce made online shopping convenient and fast for me. I could use chat commerce for asking help, if there was a problem with my online shopping.
(10)	Satisfaction with the Experience	SAT1 SAT2 SAT3	My chat commerce experience was exactly what I had expected. I am satisfied with my chat commerce online purchasing experience. I would be willing and happy to use the chat commerce as a purchasing channel in the future.

DATA ANALYSIS AND RESEARCH RESULTS

Demographic Distribution

Overall

The survey, which ran on Google Forms, collected a total of 256 responses. From those 256 responses, 29 of them answered as “No online or Chat Commerce shopping experience at all”, deeming them “unusable” for the other statistical analysis, and leaving 227 “usable” responses. Table 4 below documents the demographical distribution of the collected “usable” data.

Table 4: Demographical statistics for the actual study.

Demographics	Distribution
Generation	Baby Boomer (born in 1946-1964) : 26 / 227 (11.5%) Gen X (born in 1965-1980) : 63 / 227 (27.7%) Gen Y (born in 1981-1996) : 47 / 227 (20.7%) Gen Z (born in 1997-2009) : 91 / 227 (40.1%)
Gender	Male : 75 / 227 (33.0%) Female : 150 / 227 (66.1%) Prefer not to answer : 2 / 227 (0.9%)
Chat Commerce Experience (shopping within the last 1 year)	Some (1-4 transactions) : 82 / 227 (36.1%) Male : 35 / 82 (42.7%) Female : 47 / 82 (57.3%) Prefer not to answer : 0 / 82 (0.0%) Numerous (5 or more transactions) : 145 / 227 (63.9%) Male : 40 / 145 (27.6%) Female : 103 / 145 (71.0%) Prefer not to answer : 2 / 145 (1.4%)

Generations

The distribution of the generations of the respondents seemed reasonable. Gen Z generation, being the digital natives, had the biggest share at 40.1%; and Baby Boomers, being technology averse, had the smallest share at 11.5%. Gen X generation and Gen Y generation shared the middle of the distribution with 27.7% and 20.7% respectively.

Gender

Taking a look at the statistics on gender, we discovered that two-thirds of the respondents were females at 66.1%, and only one-third were males at 33.0%. According to Kneoma.com (2020), male to female ratio of the total population in Thailand is 94.79 to 100. In percentage terms, this approximately equates to 48.7% male and 51.3% female. The reason that we had female respondents twice as many as male respondents may be attributed to females being more amenable to participate in surveys, and do not mind to spending a few minutes of their time to fill in the survey questions for the purpose of helping others.

Also, there were 2 (0.9%) respondents who preferred not to answer the question on gender.

Chat Commerce Experience

In terms of chat commerce experience, we discovered that almost twice the number of respondents (63.9%) had numerous chat commerce shopping experiences compared to only 36.1%. This indicated that there are greater number of respondents who are willing to purchase goods/services using chat commerce in the last 1 year.

Reviewing the gender distribution of respondents with some chat commerce experience indicated that they are almost same, at 42.7% male and 57.3% female. However, for the respondents with numerous chat commerce experience, we saw that females outnumbered males more than 2.5 times, at 27.6% male and 71.0% female.

Perhaps, this is the conclusive proof that females enjoy shopping a lot more than their male counterparts, whether in the physical world or in the digital world — at least in Thailand!

Descriptive Statistics

Table 5 below presents the descriptive statistics on the mean and standard deviation for the entire dataset, as well as for each of the 4 generations.

Table 5: Descriptive statistics for the actual study.

Factor #	Factor	Mean (Standard Deviation)				
		Entire Dataset	Baby Boomer	Gen X	Gen Y	Gen Z
(1)	REL	4.053 (0.565)	4.090 (0.608)	4.079 (0.586)	3.936 (0.464)	4.084 (0.587)
(2)	ASS	4.091 (0.565)	4.221 (0.526)	4.075 (0.595)	3.984 (0.456)	4.121 (0.601)

Factor #	Factor	Mean (Standard Deviation)				
		Entire Dataset	Baby Boomer	Gen X	Gen Y	Gen Z
(3)	RES	3.906 (0.605)	4.169 (0.514)	3.835 (0.664)	3.792 (0.532)	3.939 (0.604)
(4)	EMP	3.910 (0.637)	3.990 (0.638)	3.778 (0.604)	3.862 (0.587)	4.003 (0.674)
(5)	PIQ	4.077 (0.574)	4.144 (0.588)	3.885 (0.535)	4.016 (0.509)	4.223 (0.593)
(6)	PWT	3.931 (0.625)	4.077 (0.701)	3.873 (0.517)	3.780 (0.583)	4.007 (0.679)
(7)	TIP	3.960 (0.624)	4.096 (0.583)	3.917 (0.552)	3.867 (0.601)	4.000 (0.690)
(8)	PEU	4.234 (0.572)	4.256 (0.445)	4.085 (0.571)	4.128 (0.499)	4.385 (0.608)
(9)	PUS	4.172 (0.559)	4.200 (0.503)	4.070 (0.459)	4.081 (0.548)	4.281 (0.628)
(10)	SAT	4.085 (0.626)	4.167 (0.445)	4.053 (0.608)	3.993 (0.504)	4.132 (0.732)
	Average:	4.042 (0.595)	4.141 (0.555)	3.965 (0.569)	3.944 (0.528)	4.118 (0.640)

- The green highlighted cells above are discussed in further detail below.

The values for mean of the 10 factors among the 4 generations appeared to be hovering around 3.792 and 4.385, with an average for the entire dataset at 4.042. This means that, in general, there respondents had a “[4] Agree” level of opinion about their chat commerce experience.

Similarly, the values for standard deviation of the 10 factors among the 4 generations appeared to be hovering around 0.445 and 0.732, with an average for the entire dataset at 0.595. Again, this means that, in general, the responses of all participants ranged from ~3.5 to ~4.5 (i.e., ± 0.595 standard deviation from 4.042).

Questionnaire Reliability Analysis and Results

Using the collected data from the actual survey in SPSS statistical analysis software, with 227 respondents having Chat Commerce experience, we performed a reliability analysis on our questionnaire based on Cronbach’s Alpha test, with the results show in Table 6 below.

Table 6: Cronbach’s Alpha test results for the actual survey.

Factor #	Factor (and question items, i.e., attributes)	Number of Attributes	Cronbach’s Alpha
(1)	REL (REL1, REL2, REL3)	3	0.744
(2)	ASS (ASS1, ASS2, ASS3, ASS4)	4	0.784
(3)	RES (RES1, RES2, RES3, RES4, RES5)	5	0.814
(4)	EMP (EMP1, EMP2, EMP3, EMP4)	4	0.848
(5)	PIQ (PIQ1, PIQ2, PIQ3, PIQ4)	4	0.841
(6)	PWT (PWT1, PWT2, PWT3)	3	0.789
(7)	TIP (TIP1, TIP2, TIP3, TIP4)	4	0.793
(8)	PEU (PEU1, PEU2, PEU3)	3	0.870
(9)	PUS (PUS1, PUS2, PUS3, PUS4, PUS5)	5	0.811
(10)	SAT (SAT1, SAT2, SAT3)	3	0.805

According to statistical criteria, Cronbach’s Alpha values higher than 0.7 indicate that question items in each of the 10 groups are considered reliable and quality. Therefore, with all 10 factors being above 0.7, this meant that our questionnaire was measuring what it is intended to measure (i.e., responses are not jumping around in a wide range within each set).

Normality Analysis

Before performing correlation analysis, we tested our collected data for normality (i.e., whether it demonstrates normal distribution behavior), again using SPSS statistical analysis software. Table 7 below presents Kolmogorov-Smirnov and Shapiro-Wilk normality test results.

Table 7: Normality analysis for the actual survey.

Factor #	Factor	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	p-value	Statistic	df	p-value
(1)	REL	0.198	227	0.000**	0.933	227	0.000**
(2)	ASS	0.149	227	0.000**	0.957	227	0.000**
(3)	RES	0.121	227	0.000**	0.961	227	0.000**
(4)	EMP	0.169	227	0.000**	0.952	227	0.000**
(5)	PIQ	0.173	227	0.000**	0.943	227	0.000**

Factor #	Factor	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	p-value	Statistic	df	p-value
(6)	PWT	0.192	227	0.000**	0.931	227	0.000**
(7)	TIP	0.160	227	0.000**	0.955	227	0.000**
(8)	PEU	0.253	227	0.000**	0.863	227	0.000**
(9)	PUS	0.133	227	0.000**	0.935	227	0.000**
(10)	SAT	0.256	227	0.000**	0.868	227	0.000**

- * significant at 95% confidence level (alpha=0.05)
- ** significant at 99% confidence level (alpha=0.01)

According to statistical criteria, with confidence level significant at 95% (i.e., alpha=0.05), Kolmogorov-Smirnov test p-value being 0.000 (i.e., lower than alpha) for all the 10 factors indicate that our collected data does not demonstrate normal distribution behavior. This is still valid even at confidence level significant at 99% (i.e., alpha=0.01).

Similarly, for Shapiro-Wilk test p-value being 0.000 (i.e., lower than alpha) for all the 10 factors indicate that our collected data does not demonstrate normal distribution behavior. Yet again, this is still valid even at confidence level set at 99% (i.e., alpha=0.01).

The result of this finding meant to us that to perform correlation analysis was required to be based on Spearman’s nonparametric statistics, as opposed to Pearson’s parametric statistics for normal distribution.

Correlation Analysis

For the purpose of testing whether there are correlations among the 10 factors as proposed in the research model and hypotheses relationships (in Figure 2 above), we performed Spearman’s nonparametric correlation analysis using SPSS statistical analysis software 5 times:

- [1] for the entire dataset;
- [2] for Baby Boomer generation;
- [3] for Gen X generation;
- [4] for Gen Y generation; and
- [5] for Gen Z generation.

Correlation Analysis for the Entire Dataset

Table 8 below presents Spearman’s nonparametric correlation coefficients for the 9 hypotheses (H1–H9) among the 10 factors as proposed in the research model and hypotheses relationships.

Table 8: Correlation analysis for entire dataset (n=227).

Item	Hypothesis	Factors	Coefficient	Interpretation
[1]	H1	REL→PIQ	0.487**	moderate
[2]	H2	ASS→PIQ	0.598**	moderate
[3]	H3	RES→PWT	0.535**	moderate
[4]	H4	EMP→TIP	0.559**	moderate
[5]	H5	PIQ→TIP	0.540**	moderate
[6]	H6	PWT→TIP	0.554**	moderate
[7]	H7	TIP→SAT	0.505**	moderate
[8]	H8	PEU→SAT	0.476**	moderate
[9]	H9	PUS→SAT	0.630**	strong

- Coefficient: Spearman’s nonparametric correlation coefficient
- Interpretation: Interpretation for Spearman’s nonparametric correlation coefficient
- * significant at 95% confidence level (alpha=0.05)
- ** significant at 99% confidence level (alpha=0.01)

Under the “Interpretation” column above, we present simplified a way interpreting the Spearman’s nonparametric correlation coefficients values in Table 9 below, as adopted from Newcastle University (2022) and Weir (2011).

Table 9: Simplified a way of interpreting the Spearman’s coefficient values.

Item	Value	Interpretation
[1]	0.000	perfect weak correlation
[2]	0.000 > value ≥ 0.199	very weak correlation
[3]	0.200 > value ≥ 0.399	weak correlation

Item	Value	Interpretation
[4]	0.400 > value \geq 0.599	moderate correlation
[5]	0.600 > value \geq 0.799	strong correlation
[6]	0.800 > value \geq 0.999	very strong correlation
[7]	1.000	perfect strong correlation

Correlation Analysis for Baby Boomer Generation

Table 10 below presents Spearman's nonparametric correlation coefficients for the 9 hypotheses (H10–H18) among the 10 factors for Baby Boomer generation as proposed in the research model and hypotheses relationships.

Table 10: Correlation analysis for Baby Boomer generation (n=26).

Item	Hypothesis	Factors	Coefficient	Interpretation
[1]	H10	REL→PIQ	0.732**	strong
[2]	H11	ASS→PIQ	0.785**	strong
[3]	H12	RES→PWT	0.578**	moderate
[4]	H13	EMP→TIP	0.489**	moderate
[5]	H14	PIQ→TIP	0.838**	very strong
[6]	H15	PWT→TIP	0.742**	strong
[7]	H16	TIP→SAT	0.469**	moderate
[8]	H17	PEU→SAT	0.666**	strong
[9]	H18	PUS→SAT	0.584**	moderate

Correlation Analysis for Gen X Generation

Table 11 below presents Spearman's nonparametric correlation coefficients for the 9 hypotheses (H19–H27) among the 10 factors for Gen X generation as proposed in the research model and hypotheses relationships.

Table 11: Correlation analysis for Gen X generation (n=63).

Item	Hypothesis	Factors	Coefficient	Interpretation
[1]	H19	REL→PIQ	0.586**	moderate
[2]	H20	ASS→PIQ	0.708**	strong
[3]	H21	RES→PWT	0.583**	moderate
[4]	H22	EMP→TIP	0.626**	strong
[5]	H23	PIQ→TIP	0.572**	moderate
[6]	H24	PWT→TIP	0.353**	weak
[7]	H25	TIP→SAT	0.435**	moderate
[8]	H26	PEU→SAT	0.511**	moderate
[9]	H27	PUS→SAT	0.463**	moderate

Correlation Analysis for Gen Y Generation

Table 12 below presents Spearman's nonparametric correlation coefficients for the 9 hypotheses (H28–H36) among the 10 factors for Gen Y generation as proposed in the research model and hypotheses relationships.

Table 12: Correlation analysis for Gen Y generation (n=47).

Item	Hypothesis	Factors	Coefficient	Interpretation
[1]	H28	REL→PIQ	0.485**	moderate
[2]	H29	ASS→PIQ	0.404**	moderate
[3]	H30	RES→PWT	0.493**	moderate
[4]	H31	EMP→TIP	0.637**	strong
[5]	H32	PIQ→TIP	0.425**	moderate
[6]	H33	PWT→TIP	0.393**	weak
[7]	H34	TIP→SAT	0.504**	moderate
[8]	H35	PEU→SAT	0.230**	weak
[9]	H36	PUS→SAT	0.652**	strong

Correlation Analysis for Gen Z Generation

Table 13 below presents Spearman's nonparametric correlation coefficients for the 9 hypotheses (H36–H45) among the 10 factors for Gen Z generation as proposed in the research model and hypotheses relationships.

Table 13: Correlation analysis for Gen Z generation (n=91).

Item	Hypothesis	Factors	Coefficient	Interpretation
[1]	H37	REL→PIQ	0.406**	moderate
[2]	H38	ASS→PIQ	0.627**	strong
[3]	H39	RES→PWT	0.494**	moderate
[4]	H40	EMP→TIP	0.482**	moderate
[5]	H41	PIQ→TIP	0.458**	moderate
[6]	H42	PWT→TIP	0.618**	strong
[7]	H43	TIP→SAT	0.530**	moderate
[8]	H44	PEU→SAT	0.470**	moderate
[9]	H45	PUS→SAT	0.667**	strong

Summary

As a summary, Table 14 below combines all Spearman’s nonparametric correlation coefficients for the entire dataset and for the 4 generations. With all of the numbers being positive values, all of our proposed hypotheses (H1–H45) therefore have positive influence on the proceeding factors influencing the satisfaction of chat commerce usage experience in Thailand, as designed in our research model depicted on Figure 2 above.

Table 14: Summary table combining all Spearman’s nonparametric correlation coefficients.

Item	Influencing Factors	Spearman’s Nonparametric Correlation Coefficient				
		Entire Dataset	Baby Boomer	Gen X	Gen Y	Gen Z
[1]	REL→PIQ	(H1) 0.487**	(H10) 0.732**	(H19) 0.586**	(H28) 0.485**	(H37) 0.406**
[2]	ASS→PIQ	(H2) 0.598**	(H11) 0.785**	(H20) 0.708**	(H29) 0.404**	(H38) 0.627**
[3]	RES→PWT	(H3) 0.535**	(H12) 0.578**	(H21) 0.583**	(H30) 0.493**	(H39) 0.494**
[4]	EMP→TIP	(H4) 0.559**	(H13) 0.489**	(H22) 0.626**	(H31) 0.637**	(H40) 0.482**
[5]	PIQ→TIP	(H5) 0.540**	(H14) 0.838**	(H23) 0.572**	(H32) 0.425**	(H41) 0.458**
[6]	PWT→TIP	(H6) 0.554**	(H15) 0.742**	(H24) 0.353**	(H33) 0.393**	(H42) 0.618**
[7]	TIP→SAT	(H7) 0.505**	(H16) 0.469**	(H25) 0.435**	(H34) 0.504**	(H43) 0.530**
[8]	PEU→SAT	(H8) 0.476**	(H17) 0.666**	(H26) 0.511**	(H35) 0.230**	(H44) 0.470**
[9]	PUS→SAT	(H9) 0.630**	(H18) 0.584**	(H27) 0.463**	(H36) 0.652**	(H45) 0.667**

- * significant at 95% confidence level (alpha=0.05)
- ** significant at 99% confidence level (alpha=0.01)
- The green highlighted cells above are discussed in further detail below.

Overall Results

Results for Entire Dataset

The objective of this research was to find out what factors may lead to the success of chat commerce in Thailand, and study the factors that positively influence the satisfaction of chat commerce usage experience. Ultimately, success of chat commerce is determined by positive outcomes that the customers have with Satisfaction with their chat commerce experience (SAT), as proposed in our research model and hypotheses relationships (in Figure 2 above).

Reviewing the Spearman’s nonparametric correlation coefficients in Table 14 above for the entire database, we noticed that among the 3 factors (TIP, PEU, PUS) that influence SAT, PUS (“Perceived Usefulness”) had the highest value at 0.630, indicating that the respondents pay highest attention the usefulness of the chat commerce platform.

Reviewing the Spearman’s coefficients for the factors in one tier backwards, we noticed that TIP, as influenced by EMP, PIQ and PWT, which had about the similar level of influence on TIP.

And, at the beginning of the research model, REL and ASS also had the similar level of influence on PIQ, while ASS showing slightly higher influence at 0.598, indicating that the respondents paid higher attention to assurance concepts like Service Rep understanding customers, knowledge to answer questions, and demonstrating confidence.

Results for Baby Boomers Generation

Baby Boomer generation, being older and more conservative, and not too savvy with digital technology, are instinctively technology averse, and rely on more human nature principles, like assurance and quality and simplicity. Reviewing the Spearman’s coefficients for Baby Boomers, we discover that the data is consistent with this behavior.

For the 3 factors (TIP, PEU, PUS) that influence SAT in our research model, highest among them was PEU at 0.666, indicating that ease of use (i.e., simplicity and ease of learning) was Baby Boomer generation’s most important factor for satisfaction.

For the 3 factors (EMP, PIQ, PWT) that influence TIP in our research model, highest among them was PIQ at 0.838, indicating that Baby Boomers deemed quality of information in the chat commerce platform signified highest importance to them, as higher information quality leads to greater trust in the platform.

For the 2 factors (REL, ASS) that influence PIQ in our research model, highest between them was ASS at 0.785, indicating that Baby Boomers pay attention to Service Rep's assurance, like understanding customers, knowledge to answer questions, and demonstrating confidence, which are quite essential human traits, as personal touch is important to older generation persons.

Results for Gen X Generation

Gen X generation generally demonstrate both physical world skills as well as digital world skills, as they grew up using personal computers from their early ages in 1990s.

From a satisfaction viewpoint, nothing important stand out from the 3 factors (TIP, PEU, PUS) that influence SAT in our research model, with PEU slightly above the other two, at 0.511.

In terms of trusting the chat commerce platform, we discovered that, from the 3 factors (EMP, PIQ, PWT) that influence TIP, Gen X respondents rated EMP the highest, at 0.626, as, perhaps feeling lost between the two large generations, their give higher priority to being paid closer attention to their special needs and interests.

Similarly, in terms of influencing information quality (PIQ), Gen X generation see assurance (ASS), at 0.708, more important factor than reliability (REL).

Results for Gen Y Generation

Interestingly, for Gen Y generation, among the 3 factors (TIP, PEU, PUS) that influence SAT in our research model, the least important factor for them happened to be PEU, at 0.230, as being the technology savvy generation, they can easily move through any app, no matter how badly designed it may be, and complete the chat commerce transaction with ease.

At the same time, PUS, at 0.652, emerged as the most important factor for Gen Y generation, among the 3 factors (TIP, PEU, PUS) that influence SAT in our research model. This can be attributed to the fact that Gen Y generation was present at the beginning of technological explosion of the Internet and social media during the 2000s, and usefulness of the platform weighted heavily in their satisfaction to use the chat commerce apps.

Similar to Gen X generation, Gen Y generation also considered EMP, at 0.637, an important factor that influence their trust in the chat commerce platform (TIP).

Results for Gen Z Generation

Gen Z generation, being the youngest of all, and growing up using the smartphone in their early ages in 2010s, among the 3 factors (TIP, PEU, PUS) that influence SAT in our research model, they rated PUS as their highest priority, at 0.667, as the masters of technology use, their main focus was on the usefulness of the chat commerce platform to satisfy their purchasing needs.

Another significant trait of Gen Z generation emerged in the area of trust in the platform. Being the most impatient generation, among the 3 factors (EMP, PIQ, PWT) that influence TIP, the respondents indicated PWT as their highest ranked factor, at 0.618, pointing the fact that time is an important element in their shopping behavior.

Equally important for the Gen Z generation was identified in the area of information quality. Being the generation with attention to social responsibility, assurance concepts like Service Rep understanding customers, knowledge to answer questions, and demonstrating confidence, emerged ASS as an important factor, at 0.627.

DISCUSSION AND CONCLUSION

From this study, it can be concluded that all 10 proposed factors ultimately have positive influence on Satisfaction with chat commerce usage experience, and may lead to the success of chat commerce in Thailand, while the 2 most important factors being Assurance [ASS] and Perceived Usefulness [PUS]. This was true for ASS for 3 of the generations (Baby Boomer, Gen X, Gen Z), as well as for the entire dataset; and for PUS for 2 of the generations (Gen Y, Gen Z), as well as the entire dataset. This confirms that ASS and PUS as the 2 main factors of McLean *et al.*'s (2016) research model, who, in turn took the idea from Technology Acceptance Model (TAM) of Davis (1989). In fact, Davis's TAM, is accepted as a basic and classic model for users' acceptance and use of technology including, in our case, chat commerce platforms.

We believe that the theoretical contribution of this research for the scientific community was to generate a new research model by integrating Rattanawicha *et al.*'s (2003a) "Trust in the Platform" factor into McLean *et al.*'s (2017) research model, and applying it to Thailand chat commerce market, with a view of generations of chat commerce users. The practical contribution

of this research is that the chat commerce merchants would be able to study the results of this research, and apply it to their chat commerce platforms and e-business processes for improved customer satisfaction, and ideally, increased revenues.

For the purpose of promoting chat commerce in Thailand even further, businesses can delve into the attributes of each factor to obtain greater understanding on how users from various generations perceive their experience on chat commerce platforms, by using Structural Equation Modeling (SEM) techniques. This has the potential to lead to better goods/services and increased uses of chat commerce in Thailand. Also, using the same research model, further research can be performed in markets that are neighbors of Thailand, for the purpose of analyzing Satisfaction with Chat Commerce usage experience in Southeast Asia.

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Finding customer behavior insights for content creation in material and product sourcing using specialized topic analysis

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ABSTRACT

In content creation, customer behavior insights are very important as they help creators find and create the content that drives sales. To comprehend customer needs, content creators need not just generalized information but also specific information, which can be different across markets and cultures. This information also needs some standards so it can be analyzed systematically. This paper aims to obtain customer insight into web content. Inside the web content, one possible source of this information is the tags based on customer feedback and the related entities. In this case, the product review data were collected and analyzed. However, manually analyzing feedback is a time-consuming activity. In this work, we formulated the topic analysis problem specialized for material and product sourcing, which could benefit product analysis and development. Technically, we also compared different text processing and classification methods, which set the benchmarks for reviewing the model performance in the future.

Keywords: Text classification, Customer behavior insights, Content creation, Specialized topic analysis, Material and product sourcing.

INTRODUCTION

Customer behavior insights are most important in marketing technology. Without this information, the content creators have no clues about the products or services that can attract customers, so they can only guess at their best. Without the right content, it is next to impossible to drive sales. The cost of not knowing your customers include spending resources without bringing any value and, in the worst case, losing the customers we worked so hard to acquire. This might be referred to as an unknown known problem since we do have data, but we still need to dig deeper to reach something called insights (Agrawal *et al.*, 2018).

To comprehend the customers' needs, content creators need to obtain specific information, e.g., identifying recurrent themes or topics that align with the stakeholders' needs, which can be different across markets and cultures. One way to obtain consumer insights is to analyze the contents that customers usually engage with since they indicate the types of content that customers are interested in.

Since fully manual analysis of contents and articles is a laborious and error-prone process, text classification can be used to organize and understand extensive collections of text data by assigning tags or categories to each text's topic, theme, or entities (i.e., products) of interest. Then, the manual analysis is limited to only relevant tags, which makes it more feasible but still an uphill task as the number of tags can be high, so it is difficult for the analysis to include all the relevant and correct tags.

Moreover, the assigned tags must be defined at the right level of specifications; otherwise, if it is too generalized, the tags give no new information, while if they are too specific, only a handful of text data will fall into the categories. We identified this problem as the narrow topic analysis problem.

In this work, we first formulated the narrow topic analysis problem for material and product sourcing in the architecture industry. Our narrow topic analysis involves the classification of text articles based on two types of tags: product categories and themes. This problem is challenging because product category tagging is a hierarchical classification. At the same time, the notion of themes, in this case, involves abstract, vague, and debatable concepts, such as styles and trends, since they are based on the audience's point of view. As a result, there are no consensus labels for the theme tags.

To address the above challenges of the narrow topic classification problem for creating content in material and product sourcing, we adopted the framework as shown in Fig.1, which consists of data processing for standardizing the text, feature extraction for finding the text embedding, and machine learning model for narrow topic classification. Another issue that must be addressed is the formulation of tags for the narrow topic analysis problem. When the task is ill-defined, the machine learning solution can be beneficial as it can act as the referee and gives the standard, which everyone can follow, to the problem.

However, the key ingredient needed for the AI-based solution is that all stakeholders (i.e., IT and business units in our case) must settle for the tags. All stakeholders do not need to agree on all tags, but each stakeholder must approve that the tags they need are covered.

Hence, in this paper, our contribution includes (a) a case study of formulating the narrow topic analysis problem in understanding customer behavior for creating content in material and product sourcing, which shows how the problem can be formulated even when the task is vague and ambiguous, and (b) the comparison of methods within the proposed framework for the narrow topic classification.

RELATED WORK

This article is inspired by a work categorizing products with images by a twin neural network for underspecification analysis in product design matching models (Chotisarn et al., 2021). But for this work, we changed the business domain for categorizing articles with language processing techniques.

Web extraction is an integral part of business analytics these days. World Wide Web has been considered the main source of customer behavior data. To collect data for further problem-solving, data must be extracted from origins and stored in temporary storage. Next, data will be parsed and transformed to extract the relevant information. This process might be conducted regularly (Prutsachainimmit & Nadee, 2018).

A review of text classification by Minaee et al. (2021) shows multiple applications of text classification tasks, including Sentiment Analysis, News Categorization, Topic Analysis, Question Answering (QA), and Natural language inference (NLI). The methods for automatic text classification can be categorized into two groups: rule-based methods and data-driven-based methods.

Rule-based methods classify text into different categories using a set of pre-defined rules defined by experts in the corresponding domains. The main advantage of this kind of method is interpretability, which is the ability to explain how the outcome is derived understandably. However, the downfall is that some tasks exist (i.e., theme tag classification in our case), that even the experts cannot agree on a consensus among themselves, so agreeable rules cannot be derived.

Data-driven based methods or machine learning-based methods have gained lots of attention recently. Typical machine learning-based models follow the two-step procedure, including feature extraction and classifier.

The first step involves computing some hand-crafted features from the article or any other textual unit of interest. The second step is to feed these features to a classifier to predict if they are new/unseen data or provide them to train a classifier if their outputs are known. The popular choices of classification algorithms include Naïve Bayes (John & Langley, 1995) and support vector machines (SVM) (Cortes & Vapnik, 1995).

METHOD

Our method follows the steps shown in Fig.1. First, we defined the tags, which are the expected outputs of the narrow topic analysis. Then, data processing is explained to normalize the texts. Next, feature extraction is discussed to find the article's representation (i.e., the embedding) suited for the problem. Finally, the machine learning models are described and compared with their results on our task of the narrow topic analysis problem in understanding customer behavior for creating content in material and product sourcing.

Defining Tags

Two tag sets are needed by the content creator: theme tags and product tags. These two tags are derived from every article. Their definition is given as follows:

- 1) Theme tags are the keywords that repeatedly appear in the articles. These tags then go through consultation between IT and business units to settle the set of tags that are useful for the business unit, while the IT unit keeps track of the complexity of the problem. The problem is defined as the multilabel classification, where there are possibly multiple numbers of targets for each article, while the target cardinality is two, which indicates whether the article is considered in this category.

In our case study of creating content in material and product sourcing, there are 57 tags at the end. The 57 categories can be grouped as an overview as follows;

- a. Design style, for example, modern, loft, vintage.
- b. Part of construction, for example, pole, beam, wall.
- c. Room types, for example, bedroom, bathroom, living room.
- d. Exterior, for example, terrace, garden, parking.

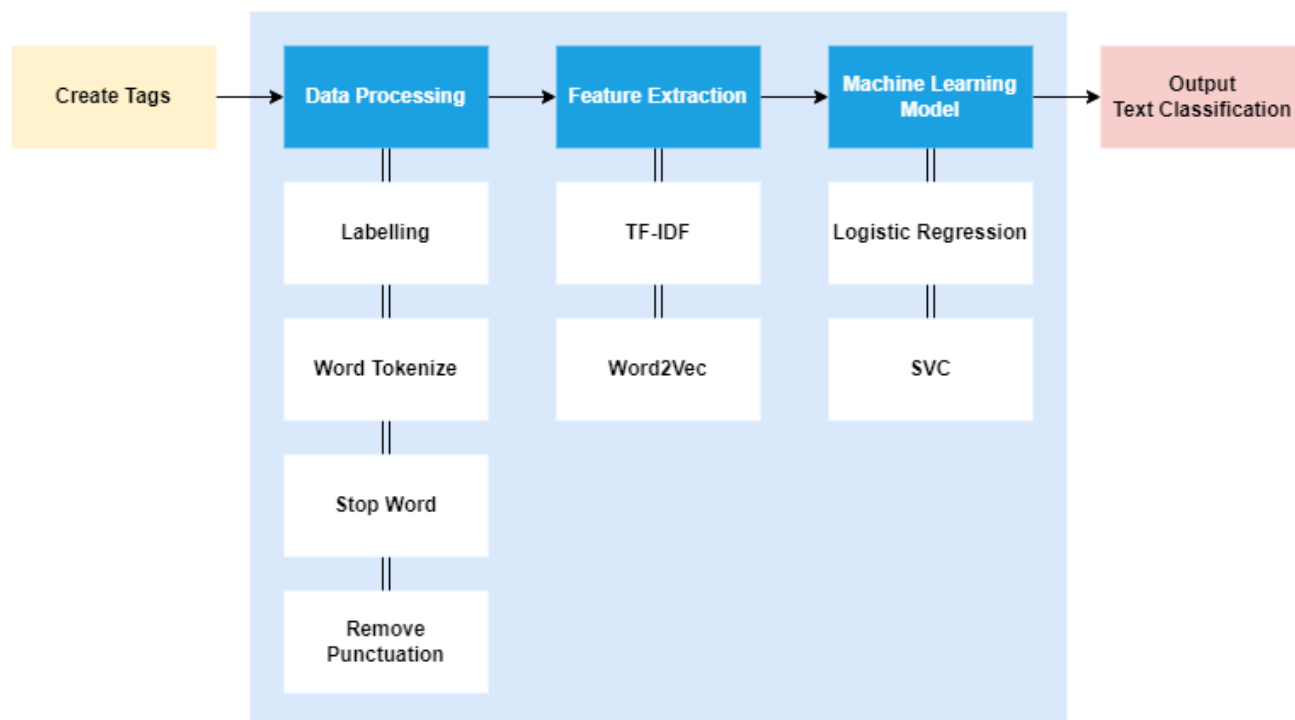


Fig.1 shows the overall steps of our method.

- 2) Product tags classify construction equipment by material type, shape, and how it is used. This information is provided by the authors of the articles but as a non-hierarchical tag, which may be incomplete or inconsistent according to the tag hierarchy we adopted. Therefore, the classification of product tags is meant to categorize and subcategory articles that are pre-tagged with human resources.

The product tag we adopted in this work consists of 23 categories and 167 sub-categories. The 23 categories can be grouped as an overview as follows;

- a. Provide information, ideas, inspirations, and history.
- b. Hidden advertising.
- c. Summary of the seminars, events, and interviews.
- d. Product and service review.

link	Bedroom	Toilet	Living	Restaurant	Hall	Balcony	Garden	Parking	Office
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[link]		1							
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[link]									1
[link]		1							
[link]		1							
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[link]									1
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Fig.2 shows the example of labelling of the contents.

- 1) Logistic Regression (LR) is selected as the baseline as it is one of the most common and fundamental models for classification problems, with a dependent variable as a discrete variable. Logistic regression uses the sigmoid function to map predicted values to probabilities.
- 2) SVM (Cortes & Vapnik, 1995) is a supervised machine learning algorithm that can be used for classification or regression problems. There are many possible hyperplanes that can be chosen to separate two classes of the data point. So, the objective of this algorithm is to find the optimal hyperplane in an N-dimensional space; N is the number of features. That distinctly classifies the data points. N is the number of features. The optimal hyperplane, with the maximum margin, provides some reinforcement so that future data points can be classified more confidently in an N-dimensional space that distinctly organizes the data points.
- 3) Label Powerset with Gaussian Naive Bayes (Label-GB) uses Gaussian Naive Bayes to classify the hierarchical label seen as a flat label through the powerset. Gaussian Naive Bayes is a variant of Naive Bayes that follows Gaussian normal distribution and supports continuous data. Naive Bayes is an algorithm based on the Bayes theorem. It is a simple classification technique but has high functionality. They find use when the dimensionality of the inputs is high. We use Label Powerset to transform the problem into a multi-class problem with one multi-class classifier, which is trained on all unique label combinations found in the training data.

EXPERIMENTS

We scraped and collected from “<https://www.wazzadu.com/>” during June and July 2021. The dataset used in the experiments contains 3,139 articles, which is split into training and test data with the ratio of 2:1. In all experiments, for word vectorization, TF-IDF uses all available words after the data preprocessing and Word2Vec uses the pre-trained vector of 300 dimensions publicly available from PyThaiNLP (Phatthiyaphaibun et al., 2016). All possible combinations of two word-vectorization techniques and three classification methods are used to perform theme tag and product tag classification (Label-GB is only applicable to the hierarchical tag, like product tags).

Two word-vectorization techniques use Python packages that include sklearn (Pedregosa et al., 2011, Buitinck et al., 2013), Word2Vec, and PyThaiNLP as follows;

- 1) `sklearn.feature_extraction.text.TfidfVectorizer` converts a collection of raw documents to a matrix of TF-IDF features equivalent to `CountVectorizer` followed by `TfidfTransformer`. In our research, except for using `TfidfVectorizer` directly, we also use the `CountVectorizer` followed by `TfidfTransformer`.
- 2) For this article, we will start Word2Vec with the Thai language. First, install `pythainlp` which only supports Python 3. Next, make Thai Word2Vec in Python with the Gensim module with `import Word2Vec from gensim.models` and `import word_tokenize from pythainlp.tokenize`.

Three classification methods use Python packages as follows;

- 1) Logistic Regression was implemented in Python by importing `LogisticRegression` from `sklearn.linear_model`. Classifier for Logistic Regression (also known as `logit` or `MaxEnt`). In this research, the “multi class” option is set to “multinomial,” and the training algorithm uses the cross-entropy loss.
- 2) Support Vector Machine was implemented in Python by `sklearn.svm`. In this research, `sklearn.svm.SVC` (C-Support Vector Classification) was selected for implementation, which is built on top of `libsvm`. Fit time scales at least quadratically with sample number and may be impractical beyond tens of thousands of samples. Consider using `LinearSVC` or `SGDClassifier` instead for large datasets.
- 3) Label Powerset with Gaussian Naive Bayes (Label-GB) was implemented in Python by importing `LabelPowerset` from `skmultilearn.problem_transform` and importing `GaussianNB` from `sklearn.naive_bayes`. Label Powerset is transforming a multi-label problem into a multi-class problem. The multi-label problem is the multiple output classes at once, while the multi-class problem is only one output at a time.

The `GaussianNB` is a classification using probability principles to help calculate. Label Powerset with Gaussian Naive Bayes (Label-GB) can use together as initialize Label Powerset multi-label classifier with a gaussian naive bayes base classifier “`classifier = LabelPowerset(GaussianNB())`”

The metrics used for evaluation (Géron, 2022) include precision, recall, and f1-score. Precision is the fraction of relevant instances among the retrieved instances, computed by formula (1), where TP is true positives and FP is false positives. The recall is the fraction of retrieved relevant cases calculated by the formula (2), where FN is a false negative. The F1-score is the harmonic mean of precision and recall, formula (3).

$$Precision = TP / (TP + FP) \tag{1}$$

$$Recall = TP / (TP + FN) \tag{2}$$

$$F1 = 2PR / (P + R) \tag{3}$$

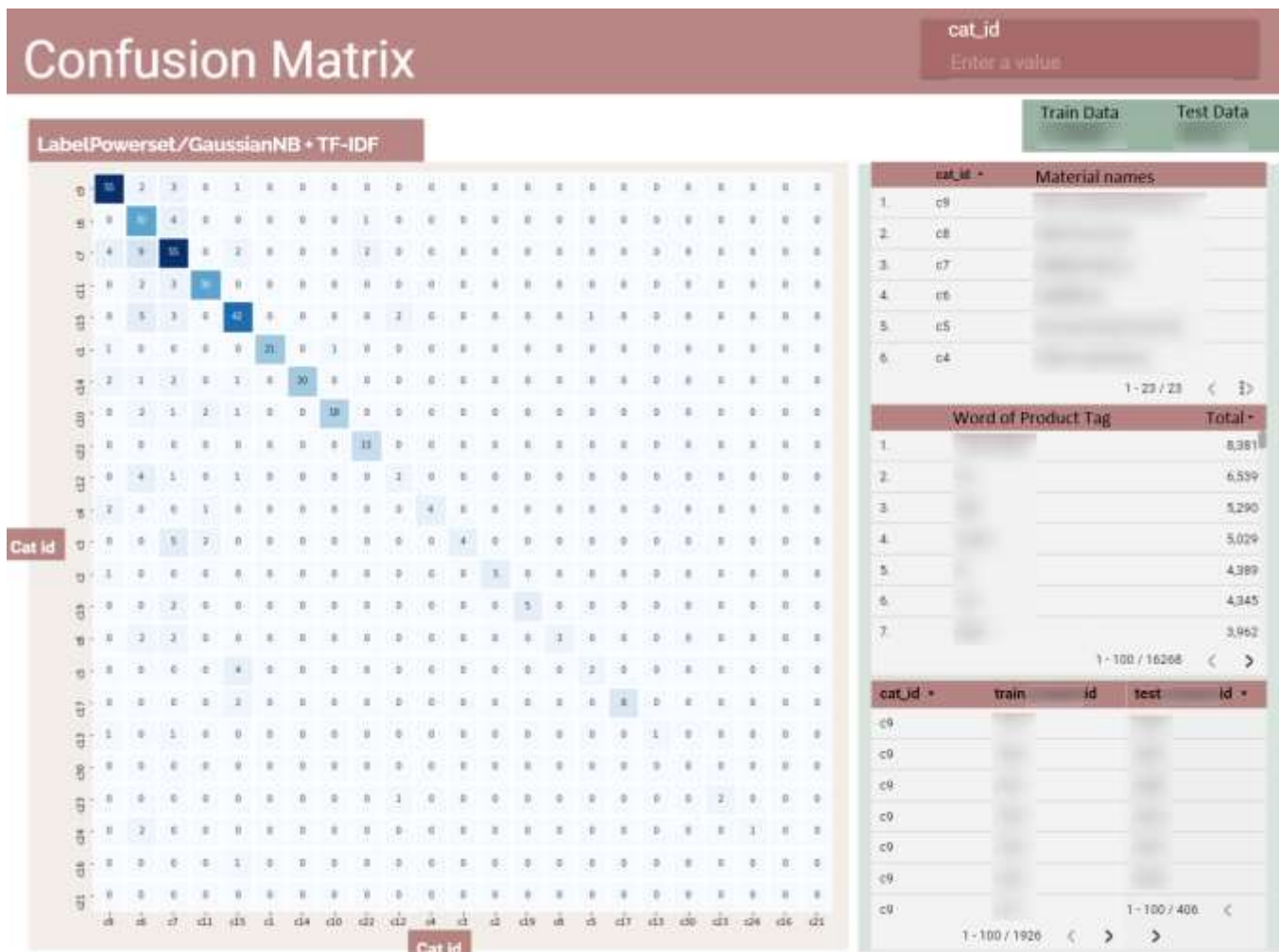


Fig.4 A confusion matrix to view model results and visualize with Looker Studio.

RESULTS

Initially, we created a confusion matrix (Géron, 2022) to view model results and visualize with Looker Studio (Fig.4). Looker Studio, formerly Google Data Studio, is an online tool introduced by Google for converting data into customizable informative reports and dashboards (Kemp & White, 2021). Google announced a free Data Studio version for individuals and small teams in May 2016. In the example, we looked at LR + TF-IDF. The confusion matrix is used to analyze whether the predictions are confused or not in each category.

For example, balcony and terrace, there may be confusion that appears in the confusion matrix that the balcony is predicted to be the terrace and the terrace is expected to be the balcony. In this case, we group it as the name c, which stands for the material category, followed by a number instead of the name. The remaining confusion matrix can be viewed to view the remaining results. But we tend to look at that matrix more broadly.

For precise predictions, the results are dark colors at the intersection of the x and y axes in the same category. We sorted them by color intensity to see which type predicted well, and the expected group had poor results. The confusion matrix helps to analyze how the model is wrong or our grouping is wrong. When viewed alongside the Precision, Recall, and F1-Score results to further improve our classification.

However, the confusion matrix is not suitable for viewing results to compare each model. We, therefore, summarize each model with an F1-score, as shown next.

Tables 1 and 2 show the test results of theme tag and product tag classification, respectively. The results show that SVM combined with TF-IDF gives the best theme and product tag classification outcome. SVM is one of the most popular methods since it usually outperforms other methods and is versatile in flat and hierarchical tags.

On the other hand, TF-IDF outperforms Word2Vec in this task, although many works pointed out that Word2Vec is better at capturing semantic attributes. We hypothesize that Word2Vec needs fine-tuning to our dataset before it can be effective.

Table 1: Experiment results of theme tags classification.

Techniques	Precision	Recall	F1-score
LR + TF-IDF	0.652	0.222	0.332
LR + Word2Vec	0.584	0.222	0.280
SVM + TF-IDF	0.658	0.262	0.375
SVM + Word2Vec	0.559	0.180	0.273

Table 2: Experiment results of product tags classification.

Techniques	Precision	Recall	F1-score
LR + TF-IDF	0.9556	0.3443	0.5062
LR + Word2Vec	0.9395	0.2307	0.3704
SVM + TF-IDF	0.9657	0.8692	0.9149
SVM + Word2Vec	0.9269	0.5945	0.7244
Label-GB + TF-IDF	0.8453	0.8397	0.8425
Label-GB + Word2Vec	0.8507	0.8419	0.8463

DISCUSSION

This paper demonstrates the process of finding customer insights from data extraction, preprocessing, feature extraction, and model selection and evaluation. We can see a big difference between Precision and Recall for the model evaluation from the theme tags classification results. And when taking it to find the f1-score, the f1-score is not much higher. It is at a level that may be called low, which is less than 0.5, which means it almost can't classify the articles. This might imply the quality of data or the availability of the models we can choose to apply in this context.

This result can be assumed to be due to the combination of Theme tags with too many categories, which makes a relatively significant difference. It's also not very good at categorizing. For example, balcony and terrace, which, when interpreted in Thai, have the same meaning. But the details are different in English. But this architectural knowledge, the labeling team may not have as much this knowledge as they should.

On the other hand, product tags, which have high precision and recall and a high f1-score, show that if product tags categorize, they can be organized well. However, looking at the data in detail, we find that the product tags are not categorized deeply in the first layer but more detail in the subsequent layers. It must be divided by the main category before going into sub-categories later. It can be said that a large number of sub-categories may not be necessary to consider, which, if taken into account, would have the same effect as the previous theme tags classification, which would be less effective.

This highlights the significant gap in language understanding in humans. Educating the human teams is still relevant and high cost. The tasks that require human hands are still subjective and error-prone. It is not feasible to find the optimum number of categories. Reinforcement or self-reinforcement learning might be able to tackle this problem. However, it is subjected to vocabulary and computation limitations.

Moreover, we use the confusion matrix with Precision, Recall, and F1-Score. The lower the value, the more confusing matrix looks like it's scattered and not concentrated. The following interpretation can complement the understanding of low numbers. It can point down to which category this small value is due to an inaccurate prediction.

CONCLUSION

We presented a case study of formulating the narrow topic analysis problem in understanding customer behavior for creating content in material and product sourcing. We started by defining the problem as tags classification and giving a guideline for determining the standard tags if none exist. The framework we used for text classification consists of data processing, word vectorization, and variety. We compared two different word vectorization methods and three different classification methods and found that SVM combined with TF-IDF gives the best results on our dataset.

Limitation

This study collected data only from one source. It would add more generalizability if data could be collected from various sources. The implications would be more complications due to different characteristics and societal backgrounds. For example, obtaining data from social media platforms like Facebook groups vs. Twitter vs. Instagram might result in various categories. Expanding the data collection scope, of course, require more computing power, storage, and resources.

Future Works

The analysis of tags for finding customer behavior insights is left for future work, along with the experiments on modern classification techniques like deep learning and building on our current project visualization regarding the use of tags as bubble visualization (Chotisarn et al., 2021). Furthermore, data is not always available and ready for analysis. The process might involve data extraction from the source as part of the data acquisition (Prutsachainimmit & Nadee, 2018).

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Healthcare gamification: Science mapping the body of literature

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ABSTRACT

Healthcare gamification is a research topic being investigated in numerous contexts. As it is an interdisciplinary subject, it is hard for researchers to keep up with the research published in these venues. This paper aims to unveil the intellectual structure of the healthcare gamification research field through a systematic literature review. We apply a science map strategy to a 520-document database. This database was analyzed to build an evolutionary map revealing the most co-cited authors, their publications, and the theories used. Results evidence that referenced research can be classified into six research traditions. Finally, research opportunities are presented.

Keywords: Healthcare gamification, SciMAT, co-citation, intellectual structure.

INTRODUCTION

Healthcare Gamification Scattered Research Field

Gamification is defined as "the use of game design elements in non-game contexts" (Deterding *et al.*, 2011a:2). During the last years, gamification has been recognized as a promising trend as pieces of evidence of its effectiveness exist (Koivisto & Malik, 2021). So far, many different gamification studies have been developed in diverse contexts, such as education, social networks, online communities, sustainability, marketing, and healthcare.

In the healthcare context, numerous subareas of gamification research arose. For example, studies exist in gamification for supporting the practice of exercises and physical activity, correcting nutrition imbalance, advancing mental health care, allowing the self-management of chronic diseases, supporting physical rehabilitation, and helping the education of medical professional.

Healthcare gamification is considered a valuable means to engage different interest groups in healthier behaviors (Schmidt-Kraepelin *et al.*, 2018) and positively spawn enjoyment, compliance with health-related activities, and effective health outcomes (Stepanovic & Mettler, 2018). Consequently, gamified healthcare-related initiatives have been developed in many significant ways. Whereas World Health Organization (WHO) has emphasized health technology as an indispensable means for achieving effective and efficient prevention, diagnosis, treatment, and rehabilitation of diseases, with the help of gamification, it became feasible to attain the health-related development goals listed in the Millennium Declaration (World Health Organization, 2007).

Because gamification is such a promising approach to stimulating health behavior change (Johnson *et al.*, 2016), it has fostered fast-growing research streams with multiple venues yet to be explored (see Johnson *et al.*, 2016; Schmidt-Kraepelin *et al.*, 2018). However, the spread of interest in this multidisciplinary topic has led to a profusion of research publications and a multiplicity of journals that are troublesome for researchers to stay updated with the knowledge developed (Schmidt-Kraepelin *et al.*, 2018).

Researchers interested in studying healthcare gamification face the problem of dealing with much new knowledge scattered along multiple scientific outlets. Successful researchers have to work with literature reviews because new knowledge generation requires establishing of a critical foundation for its advancement (Webster & Watson, 2002). Literature reviews are helpful to evaluate the breadth of a specific research domain, synthesize it, develop theories and provide a conceptual background for the flourishing of new studies on the topic, which will explore the topics that require further investigation (Paré *et al.*, 2015). Knowledge accumulation is fundamental for a field to be recognized as scientific and consequently develop (Paré *et al.*, 2015), and literature reviews are a crucial strategy to obtain a comprehensive overview of a topic (Green, Johnson & Adams, 2006).

Despite the multiplicity of approaches of types of literature reviews on healthcare gamification (e.g., Hamari, Koivisto & Sarsa, 2014; Seaborn & Fels, 2015; Theng *et al.*, 2015; Alahaivala & Oinas-Kukkonen, 2016; Lewis, Swartz & Lyons, 2016; Johnson *et al.*, 2016; Matallaoui *et al.*, 2017; Sardi, Idri & Fernández-Alemán, 2017; Schmidt-Kraepelin *et al.*, 2018), none of them has been so far conducted based on co-citation science maps, a notable strategy that can reveal important research traditions,

prominent authors and publication venues on the topic (Shafique, 2013). Fortunately, a specific variant of literature review can perform this analysis by providing the intellectual structure (InS) of a topic. InS is defined as "a set of salient attributes of the knowledge base that can provide an organized and holistic understanding of the chosen scientific domain (...) its constituent research traditions, their disciplinary composition, topics addressed by these, and the pattern of their interrelationships" (Shafique, 2013:63).

Revealing healthcare gamification InS is a promising strategy to promote a deeper understanding of this research area and complementarily identify some of its relevant investigation opportunities. In consequence, we performed a systematic literature review by applying InS techniques (Shafique, 2013) over a 520-document database, published from 2012 to 2020, to provide an extensive view of this field by identifying the essential research traditions, the prominent authors, the publication venues (from both journal and conferences) and the relevant documents researched all across the studied timeframe.

In the following sections, this research is structured as follows: The next part will cover some past literature reviews in healthcare gamification; followed by a methodology section, covering central methodological procedures adopted by this research; a results exposition part, where co-citation analysis findings are depicted; a discussion section, where these results are related to actual healthcare gamification literature and finally a conclusion part where authors highlight the outcomes of this research.

LITERATURE REVIEW

An Overview of Healthcare Gamification Literature Reviews

Gamification is a way to incentive people to change behaviors and reinforce desired behavioral traits (Schmidt-Kraepelin *et al.*, 2018). Many literature reviews on gamification in general and healthcare gamification exist. Table 1 offers a summary of these studies. We group them into three distinct groups. The first group contains studies that developed initial reviews of gamification in general terms. They are focused on clarifying if gamification is an effective strategy (Hamari, Koivisto & Sarsa, 2014) and how gamified interventions can be predicted by gamification theories (Seaborn & Fels, 2015). Both studies do not focus on healthcare gamification. The second group developed literature reviews focused on topics like investigating gamification and videogame effects on diabetes self-management (Theng *et al.*, 2015), the use of contextual information on the development of healthcare gamified interventions (Alahaivala & Oinas-Kukkonen, 2016), how the rewards gamification element was used on the healthcare context (Lewis, Swartz & Lyons, 2016), and how gamified interventions were used for exercising (Matallaoui, 2017). Finally, the third group in which our study can be added is set to explore gamified interventions with healthcare systems. The studies in this group looked for pieces of evidence of healthcare gamification effectiveness, how it was used, what audiences and healthcare domains were targeted (Johnson, 2016), and aimed to point out the essential articles and authors, past research foci, and potential future research gaps (Schmidt-Kraepelin, 2018).

It is worth mentioning that none of the reviews above provides an analysis of the intellectual structure of the healthcare gamification literature.

Table 1: Literature reviews on general gamification and healthcare gamification.

Author(s)	Articles	Range	Method	Context	The focus of the analysis	Keywords/Search string	Databases
Hamari, Koivisto & Sarsa (2014)	24	2008 - 2013 ¹	Meta-analysis	General	Empirical findings on implemented motivational affordances and related psychological and behavioral outcomes in gamified systems.	gamification, gamif*, gameful and motivational affordance.	Scopus, ScienceDirect, EBSCOHost, Web of Science, ACM Digital library, AISel, Google Scholar, and Proquest.
Seaborn & Fels (2015)	30	2013	Meta-analysis	General	Applied and evaluated examples of gamification and conceptual work.	gamification OR gamif*	EBSCOhost, JSTOR, Ovid, ProQuest, PubMed, Scopus, and Web of Knowledge
Theng <i>et al.</i> , (2015)	10	2000 – 2014	Meta-analysis	Healthcare	The use of games, gamification, and virtual environments for diabetes self-management.	diabetes with gamifi* OR virtual reality OR virtual environment OR video gam* OR mobile gam* OR computer gam*	PubMed, Web of Science, Scopus, and PsychINFO
Alahaivala & Oinas-Kukkonen (2016)	15	2011 – 2015	Meta-analysis	Healthcare	Persuasion contexts of gamified health behavior support systems.	gamif* and health*	Elsevier Scopus, ISI Web of Science, PubMed, EBSCOHost, ACM Digital Library, and IEEE Explore.
Lewis, Swartz & Lyons, (2016)	18	Undefined – 2015	Meta-analysis	Healthcare	The use of reward systems in health-related gamified interventions.	Gamification was truncated to gamif*; Rewards was truncated to reward*, incentive*, reinforce*, conting*, motivate*, encourag*, entic*, or point*. "Intervention" was truncated to interven* or randomiz*	Medline OVID, Medline PubMed, Web of Science, CINAHL, Cochrane Central, and PsycINFO.
Johnson <i>et al.</i> , (2016)	19	Undefined – 2015	Meta-analysis	Healthcare	Empirical findings on the effectiveness and quality of health and well-being gamification applications.	Gamif* AND (health OR mental OR anxi* OR depres* OR wellbeing OR wellbeing)	Ebscohost, ProQuest, Association for Computing Machinery (ACM), IEEE Xplore, Web of Science, Scopus, Science Direct, and PubMed.
Matallaoui <i>et al.</i> , (2017)	25	Every paper published before 2015	Meta-analysis	Healthcare	Empirical findings on gamified systems and serious games for exercising. Review of deployed motivational affordances and the effectiveness of gamification features in exergames	(TITLE-ABS-KEY (virtual realit*) AND (TITLE ABS-KEY (exerc*) OR TITLE ABS-KEY(physical activ*)) AND TITLE-ABS KEY (gam*) AND NOT (TITLE-ABS-KEY (therap*) OR TITLE-ABS-KEY (rehab*)))	Scopus
Sardi, Idri & Fernández-Alemán, (2017)	46	2000 – 2015	Meta-analysis	Healthcare	Benefits and pitfalls of employed gamification strategies and serious games in e-Health.	(App* OR framework* OR system* OR electronic*) AND (*health* OR *PHR* OR *EHR* OR medic* OR clinic* OR patient*) AND (gamif* OR game elements OR game* OR game mechanics)	IEEE-Xplore, ACM Digital Library, ScienceDirect, SpringerLink, Wiley Interscience, PubMed, and GoogleScholar.

Author(s)	Articles	Range	Method	Context	The focus of the analysis	Keywords/Search string	Databases
Schmidt-Kraepelin <i>et al.</i> , (2018)	74 / 2.457	2009 – 2018	Citation Network Analysis	Healthcare	Recent developments of research on healthcare gamification, past research foci, and knowledge gaps.	TITLE-ABSTR KEY(Gamif*) and TITLE-ABSTR-KEY(health* OR medic* OR exer* OR life* OR therap* OR fitness OR patient OR wellness)	IEEEExplore, EBSCO Host, ACM Digital Library, Science Direct, PubMed, ProQuest, and AISel
This research	520 / 17.169	2012 -2020	Science Map	Healthcare	Healthcare gamification main referenced authors and researched topics	(Gamif*) and medic* OR exer* OR life* OR therap* OR fitness OR patient OR wellness	Scopus

Source: Adapted from (Schmidt-Kraepelin *et al.*, 2018). ⁴the authors do not mention a time range of the database search, but articles reported were published from 2008 to 2013.

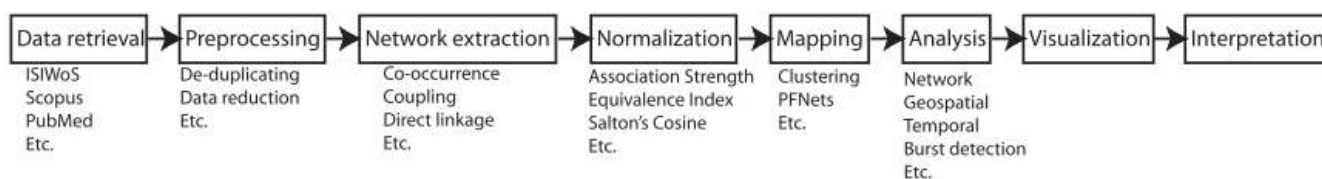
METHODOLOGICAL PROCEDURES

Science Mapping

Our literature review allows composing the InS of healthcare gamification longitudinally. This approach is different from previous literature reviews. Some streams explored gamification in a general way (e.g., Hamari, Koivisto & Sarsa, 2014), while others explored specific healthcare gamification scenarios (e.g., Theng *et al.*, 2015) and focused on studying the healthcare gamification empirical findings (Johnson, *et al.*, 2016), explored the rewards systems used in gamification interventions (Lewis, Swartz & Lyons, 2016), investigated the persuasion contexts in which gamification was implemented (Alahaivala & Oinas-Kukkonen, 2016). Still some focused on identifying healthcare gamification's recent developments (Schmidt-Kraepelin *et al.*, 2018). We applied science mapping to explore healthcare gamification.

The science mapping strategy exhibits structural and dynamic aspects of scientific research by applying co-citation analysis techniques (Cobo *et al.*, 2011a). The dynamic aspects of the advancement of the topic literature are observed by denoting how the changing structure transforms over time (Börner, Chen & Boyack, 2003). The intellectual structure of a research area comprises a set of salient attributes, such as its research traditions, disciplinary composition, topics addressed, and patterns of their interrelationships, that provide an understanding of any specific scientific domain (Shafique, 2013). A research tradition "refers to a fairly broad but distinguishable part of scientific literature in a field of research. It is a coherent collection of various subgroups of research themes/fronts that are identifiable through shared topic and common theoretical perspectives" (Shafique, 2013:62). When published documents are treated as points within a research field and related according to their co-citation levels, it becomes possible to create maps revealing the disciplines that these documents belong to, their authors, themes, and the relationship between all these aspects (White & Griffith, 1981).

In practice, science mapping is grounded on the quantitative approach of bibliometric research methods to create a visual representation of the structure of the research area built by clustering the research area elements (e.g., documents, words, journals) (Zupic & Cater, 2015). We use the procedures described by previous literature on the method (Cobo *et al.*, 2011a; Cobo *et al.*, 2011b; Cobo *et al.*, 2012; Shafique, 2013), which are composed by eight steps: data retrieval, preprocessing, network extraction, normalization, mapping, analysis, visualization, and interpretation (Figure 1).



Source: Cobo *et al.*, 2012.

Figure 1: Science mapping workflow.

Plenty of analytical software exists to support science mapping. For more information on the pros and cons of each software, see the review by Cobo *et al.* (2011a). Our study adopted SciMAT (Cobo *et al.*, 2012). The main advantages of SciMAT over other science mapping tools are "the capability to choose the methods, algorithms, and measures used to perform the analysis through the configuration wizard; (...) the use of impact measures to quantify the results; (...) the ability to perform all the steps of the science mapping workflow" (Cobo *et al.*, 2012:1627).

Data Collection

We based the data retrieval phase on the Scopus database. Most bibliometric software packages support the Scopus data importing process - SciMAT included - and is more accurate for developing co-citation, as it offers data for every author and reference cited (Zupic & Cater, 2015). We searched a research string to find relevant documents based on Schmidt-Kraepelin (2018) (see Table 2 for further details on database retrieval). They developed what was - until the realization of this specific research initiative, to the best of our knowledge - the most extensive literature review on healthcare gamification published, selecting 74 documents.

On the data collecting procedure an initial set of 2.134 documents was found from our string application. These documents were filtered, eliminating 301 documents to obtain only conference papers, articles, reviews, and editorials, with the language being English or Portuguese, totaling 1.833 documents left.

Since authors usually cite documents relevant to their work, citations can be used as a proxy of the paper's influence so that it can be considered relevant if an article is heavily cited (Zupic & Cater, 2015). To make the number of documents manageable, we ranked the 1.833 documents by citation and selected the fourth quartile (Q4 - 459 documents). While the full 1.833 documents database represented 12.931 citations, the 459 documents in Q4 represent 88,53% (11.449) of these total citations, which is deemed a good representation of their relevance.

Table 2: Summarized research design.

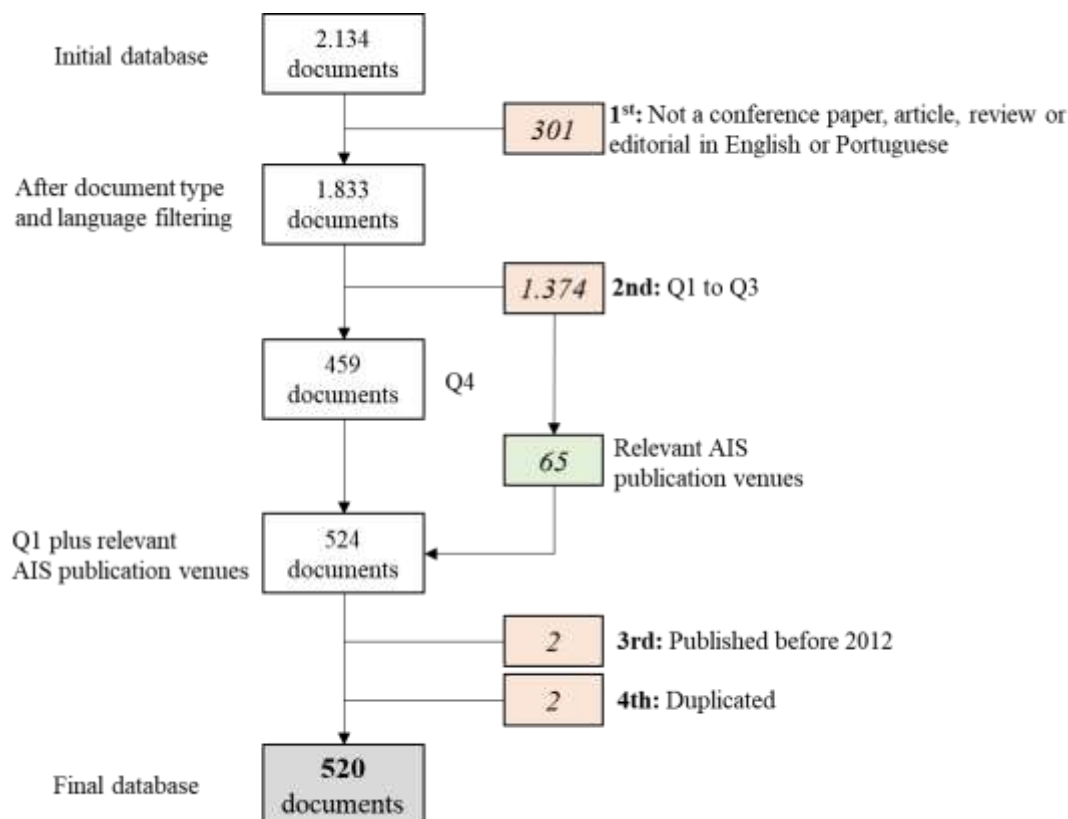
Procedure	Research design
Data retrieval: define the collection parameters and databases to which they will be applied	Research string: article title, abstract, keywords [<i>gamif*</i> AND <i>health*</i>] OR [<i>gamif*</i> AND <i>medic*</i>] OR [<i>gamif*</i> AND <i>exer*</i>] OR [<i>gamif*</i> AND <i>life*</i>] OR [<i>gamif*</i> AND <i>therap*</i>] OR [<i>gamif*</i> AND <i>fitness</i>] OR [<i>gamif*</i> AND <i>patient</i>] OR [<i>gamif*</i> AND <i>wellness</i>]. Database: Scopus. Filtering: a) only conference papers, articles, reviews and editorials, with the language being English or Portuguese, were considered. b) Q4 c) Plus relevant IS publication venues.
Preprocessing: define the preprocessing procedures to be applied to the collected data	Misspelling: authors, documents, journals and references. Deduplication: authors, documents, journals and references.
Network extraction: define the parameters for the network extraction	Periods: Single-year periods (Cobo <i>et al.</i> , 2011a). Unit(s) of analysis: references. Data reduction: Only considered references cited at least two times (Zupic & Cater, 2015).
Normalization: define technique(s) that will be applied to network normalization	Network reduction: Only considered references co-cited at least 2 or 3 times, depending on the subperiod analyzed (Zupic & Cater, 2015). Similarity(ies) measure(s): equivalence index (Cobo <i>et al.</i> , 2011a).
Mapping: define techniques(s) that will be applied to network mapping	Method: simple center algorithm (Cobo <i>et al.</i> , 2011a)
Analysis: define techniques(s) that will be applied to network analysis	Technique(s): Co-citation (Small, 1973) analysis.
Visualization: define technique(s) that will be applied to network visualization	Technique(s): Strategic diagrams and evolution map (Cobo <i>et al.</i> , 2012).
Interpretation: define the interpretation strategy for the study	Strategy(ies): Structure and dynamics (Zupic & Cater, 2015).

Source: Adapted from Zupic & Cater, 2015; Cobo *et al.*, 2012.

To minimize the risk of excluding papers representative of the IS field but conceivably not highly cited ones, we searched within Q1, Q2, and Q3 for documents published in the Senior Basket of 8 journals from the Association for Information Systems (AIS) (AIS, 2011), AIS conferences (AMCIS, ICIS, PACIS, ECIS and HICCS) and the Special Interest Groups (SIGs) SIGHealth and SIGHCI recommended journals lists (AIS, 2011). As a result, we identified 65 additional documents added to the 459 documents in Q4, creating a database of 524 documents.

Only two documents from the collected database were published before 2012. They were excluded for two reasons: our research strategy smooth of data could be avoided if subperiods were divided spanning only one year each (Cobo *et al.*, 2011a), and these individual documents do not represent enough data to obtain information for their respective years. Finally, we ran a deduplication process and eliminated two documents.

This final study database comprises 520 documents published in 352 different publication sources, of which 195 (55,39%) are journals, and 157 (44,61%) are academic events such as congresses, conferences, and symposiums. Figure 2 summarizes the steps of the data retrieval phase.



Source: This study.

Figure 2: Data retrieval process summary.

Documents Processing

The final database passed through a preprocessing phase composed of two steps: misspelling correction and deduplication. The misspelling correction helped correct, for example, author name misspellings. On the other hand, the deduplication process identified and consolidated data from similar documents labeled in slightly different forms.

Cited references (17,169 different cited documents) are used as a basis to build the science maps. The criteria adopted to extract the networks was the co-occurrence relation (Cobo *et al.*, 2012), after which a normalization process was applied (Cobo *et al.*, 2011a) based on the equivalence index (Cobo *et al.*, 2011a).

Co-citation analysis uses reference information (Small, 1973). Co-citation is the "frequency with which two items of earlier literature are cited together by the later literature" (Small, 1973:265). We adopted the equivalence index (Cobo *et al.*, 2011a) to develop the normalization process and the simple center's algorithm (Cobo *et al.*, 2011a) for clustering the documents. Both options fit this study's desired type of analysis (Cobo *et al.*, 2011a; Zupic & Cater, 2015).

RESULTS

An evolutionary map is a tool employed in this phase. It allows revealing the structure of elements that compound the healthcare gamification research field and its associated themes.

Co-Citation Analysis

It is plausible to assume that papers frequently referenced by others represent critical concepts about a specific research field. So, it turns logical to think that co-citation patterns can map similar papers, and their interconnections are an objective means to characterize a research field InS (Small, 1973). Based on these ideas, we identify and describe the main clusters of documents over nine years, from 2012 to 2020, and determine their research traditions. Besides, we also depicted publication venues and theories adopted by these documents.

The first step in building this co-citation analysis is preprocessing the references database. Two processes compose this phase: misspelling and deduplication treatment. For misspelling correction, we searched the whole database for author or document name errors (e.g., SchÄbel, S. to Schöbel, S.). SciMAT allows searching and comparing document titles and the name of authors using Levenshtein distance for deduplication treatment. The whole database was analyzed using this feature, looking for a Levenshtein distance of 1. Following, we manually deduplicated equivalent documents but found multiple wordings (e.g., De Vries, N.M. and de Vries, N.M.), uniformizing them under a single name.

All documents together contained 17.169 unique references. Their citations ranged from 308 (the most cited reference) to 1 (2.598 single cited references). As a reduction criterion, we configured SciMAT to use only references cited a minimum of two times. Consequently, the final database comprised a total of 2.221 unique references. We then extracted only references that cooccurred two times. Figure 3 shows the evolution map generated according to these parameters. We verified thirty-three clusters within the nine one-year periods. The sphere size is related to document quantity in each cluster, a parameter also related to the numbers inside the spheres. The name of the clusters is related to the main cluster document. Primary cluster documents have the highest number of co-citations within the cluster documents. Lines connecting clusters can have two different meanings: a solid line means that the principal author of the cluster is contained within the next cluster, while dotted lines mean that both clusters share elements but not the main one (Cobo *et al.*, 2011a).

Additional Qualitative Analysis

Aiming to reveal how the literature venues evolved, we did a more in-depth analysis within the sixteen clusters with evidence of continuity (those connected by solid or dotted lines). These clusters are composed of 129 unique documents that were individually analyzed.

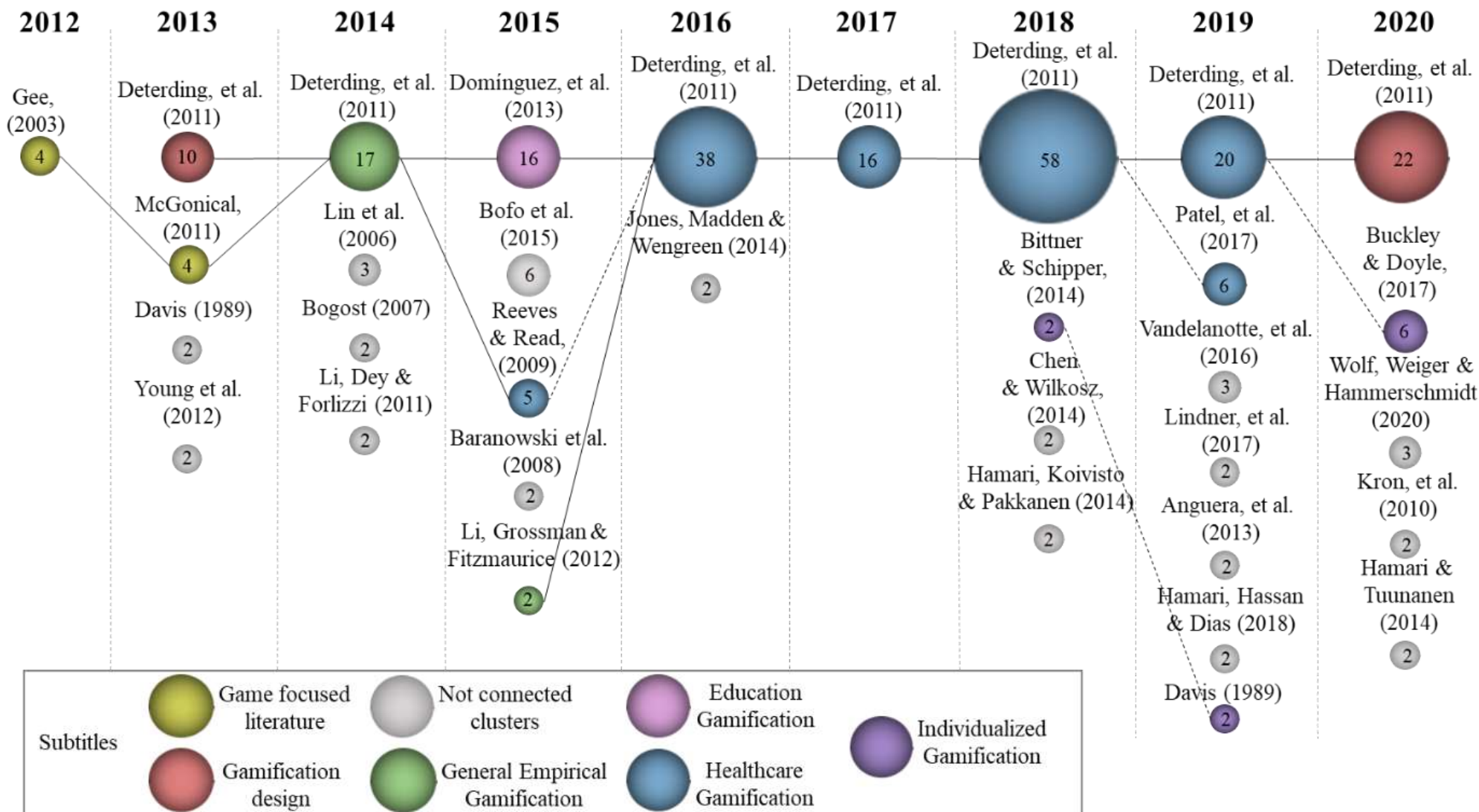
Publication Venue

We explored these documents aiming to identify in which journal they were published and found that documents have been published primarily in scientific journal papers (79 documents) but also in academic events (31 documents), books (18 documents), and magazines (1 document). Table 3 shows the complete list of journals. Within the basket of eight, we found MIS Quarterly (4 papers) and Journal of Management Information Systems (1 paper). The Journal of Medical Internet Research (4 papers) and the International Journal of Medical Informatics (1 paper) are indexed in SIGHealth journal list. We also found papers from Computers in Human Behavior (6 papers) and the International Journal of Human Computer Studies (1 paper) related to the journal list recommended by SIGHCI.

Moving our attention to the academic events, we found that each event registered only one publication, so none of them deserved special attention. However, from the Association for Information Systems (AIS) conferences list, we identified The 21st European Conference on Information Systems, the 2003 Pacific Asia Conference on Information Systems, and the 47th Hawaii International Conference on System Sciences with one publication each.

A diverse number of themes composed the list of books: the Octalysis gamification framework (Chou, 2019), flow theory (Csikszentmihalyi 1975), self-determination theory (Deci & Ryan, 1985), game design principles (Zichermann & Cunningham, 2011), grounded theory methodology (Glaser & Strauss, 1967), and the classical Homo Ludens by Huizinga (2014) who wrote about the act of playing, are some examples.

Finally, Interactions, a magazine published since 1994 by the Association for Computing Machinery and dedicated to professionals, brought Deterding's (2012) article about gamification design to our analysis.



Source: This study.

Figure 3: Evolution map of clusters revealed by co-citation analysis.

Table 3: List of identified journals.

Journal Name	# ¹	Journal Name	# ¹
Computers in Human Behavior	6	Journal of Biomedical Informatics	1
JMIR Serious Games	5	Internet Interventions	1
MIS Quarterly	4	International Journal of Human-Computer Studies	1
Computers & Education	4	International Journal of Medical Informatics	1
Journal of Medical Internet Research	4	Electronic Markets	1
Pharmacy and Therapeutics	2	Health Informatics Journal	1
International Journal of Information Management	2	Translational Behavioral Medicine	1
Communications of the Association for IS	2	Contemporary Educational Psychology	1
Personal and Ubiquitous Computing	2	Colorectal Disease	1
American Medical Association JAMA	1	Hernia	1
Annals of Internal Medicine	1	Information and Software Technology	1
Psychological Bulletin	1	Cyberpsychology & Behavior	1
JAMA Intern Med	1	BMJ Open	1
PLOS Medicine	1	Educational Technology Research and Development	1
Psychological Inquiry	1	American Journal of Health Promotion	1
Neurology	1	Journal of Educational Technology & Society	1
Review of Educational Research Spring	1	BMC Sports Science, Medicine and Rehabilitation	1
British Journal of Dermatology	1	Motivation and Emotion	1
American Psychologist	1	International Journal of Human-Computer Interaction	1
The American Psychologist	1	Human Factors and Ergonomics in Manuf. & Service Ind.	1
Pediatrics	1	Clinical Kinesiology	1
Journal of the Royal Society of Medicine	1	Academic Exchange Quarterly	1
Journal of Marketing Research	1	International Journal of Computer Science in Sport	1
American Journal of Preventive Medicine	1	Int. Journal of Business Science and Applied Manag.	1
JMIR Mhealth Uhealth	1	JMIR Research Protocols	1
Econometrica	1	Journal of Consumer Marketing	1
Journal of Management Information Systems	1	Journal of MUD Research	1
Electronic Commerce Research and Applications	1	The Journal of Marketing Theory and Practice	1
Human Relations	1		

Source: This study. ¹number of papers clustered

Research Topics and Theories

In addition to publication venues, each of the 129 documents was read and classified according to its research topic. After the individual document classification, we classified and colorized their clusters according to the predominant research topic revealed by the documents, unveiling six main research traditions: game-focused literature, gamification design, general empirical gamification, education gamification, healthcare gamification, and individualized gamification (Figure 3).

We also looked for the theories supporting the papers. We identified five theories: Self-determination theory, flow theory, technology acceptance theory, goal-setting theory, and prospect theory. Clusters formed mainly by literature referring to games instead of gamification characterize the beginning of the evolution maps. For this reason, these clusters form the game-focused research tradition. The game-focused literature 2012 cluster, for example, is entirely composed of books that exposed narratives related to games and the potential benefits they could offer to their players (e. g. Gee, 2003; McGonigal, 2011). They argue about the believed potential of games in making people feel better and completely changing the world as we know it (Mcgonigal, 2011). McGonigal's (2011) book reappears as the central cluster document in the game-focused literature cluster from 2013. This year reveals, however, not only other game-focused literature documents (e.g., Reeves & Read, 2009) but a paper that explored a practical gamified intervention in the education context (Kapp, 2012) and a first reference of the flow theory (Csikszentmihalyi, 1975). We investigated documents citing Csikszentmihalyi's (1975) and his flow theory, and it became possible to identify theoretical developments of his theory. One of them argues that flow is part of a video game mechanism group supporting scientific thinking (Morris *et al.*, 2013). Another proposes a new concept, called gamefulness, and positions it concerning flow theory (Landers *et al.*, 2019). Additionally, a study presents the flow scale-2, investigating a strategy to measure the flow state (Hamari & Koivisto, 2014).

Additionally, 2013 presented the first cluster related to the gamification design research tradition. Gamification design clusters are those in which most documents focus on exploring different strategies to design gamified systems and evaluate their effectiveness (e.g., Deterding *et al.*, 2011b). Still, 2013 is the first year Deterding's (2011a) seminal work conceptualizing gamification appeared in a cluster. It emerged in a coordinated movement characterized by his document increasing its importance and the game-focused literature diminishing its evidence, as it becomes observable from this and following clusters from the evolution map.

In 2014 a single cluster was connected to the research tradition network. It was primarily marked by general empirical gamification studies (e.g., Hamari, Koivisto & Sarsa, 2014) and minorly by context-specific ones. While one of these studies

aimed to gamify learning experiences (Domínguez *et al.*, 2013), others developed research in the healthcare gamification context (King *et al.*, 2013). Clusters of general empirical gamification research tradition empirically investigate, understand, or evaluate gamification effects in a general way, not context or user-type-focused.

Evidence from the evolution map suggests that this movement towards referencing studies that focused on understanding general and specific practical impacts of gamification applications got stronger as documents with such characteristics portray the three clusters generated in 2015. While the smallest cluster relates to general empirical gamification research tradition (e.g., Li, Grossmann & Fitzmaurice, 2012), the other two are context specific. They contain mainly healthcare empirical gamification and game-based studies (e.g., Brach *et al.*, 2012; Kato *et al.*, 2008) and education empirical gamification studies (Domínguez *et al.*, 2013). Still, this late cluster also revealed a high co-citation level of self-determination theory (SDT) related documents (Deci, Koestner & Ryan, 1999). Xu, Buhalis & Weber (2017) applied SDT within the tourism gamification context, and Seaborn & Fels (2015) review recognizes SDT as a fundamental theory within gamification research. Unlike clusters on general empirical gamification research traditions, those related to healthcare and education gamification research traditions are formed mainly by documents aiming to evaluate practical gamified interventions within these specific contexts.

Evidence from the co-citation analysis data suggests that the period between 2015 and 2016 began a movement where healthcare gamification publications significantly started to reference other healthcare gamification documents within their research. Aligned to this interpretation, the 2016 healthcare gamification cluster exposed mainly documents that investigated how gamification could benefit physical activity (e.g., Zuckerman & Gal-Oz, 2014), exercise (e.g., Hamari & Koivisto, 2015), fitness apps (e.g., Chen & Pu, 2014) and cancer pain management (e.g., Stinson, *et al.*, 2013).

This tendency continued in 2017, where the identified healthcare gamification cluster showed mainly documents relating to gamification implications towards health behavior change (Cugelman, 2013), chronic disease management (Miller, Cafazzo & Seto, 2016), and again, exercise (Hamari & Koivisto, 2015).

Alongside the majority of documents related to healthcare gamification (e.g., Johnson *et al.*, 2016; Miller, Cafazzo & Seto, 2016), the healthcare gamification cluster from 2018 is the first in which a few documents are related to different medicine areas (e.g., dealing with diseases like multiple sclerosis (Connor *et al.*, 2014)), and dermatological issues (Hamilton & Brady, 2012)), suggesting that gamification kept evolving as a broad multidisciplinary implementation. Their identification was possible considering their publication journals and that there was no mention of games or gamification within them.

A second cluster also appeared in 2018 and was related to the individualized gamification research tradition. Alike others from this research tradition, this cluster mostly revealed documents focused on the one size does not fit all approach to gamification (Akasaki *et al.*, 2016). This approach focuses on investigating different aspects, such as context, preferences, and characteristics of users, that potentially influence effectiveness levels generated by gamification intervention. Studies from the 2018 individualized gamification cluster investigate, among other questions, how differences in age and motivational effects of the users are related to gamification effectiveness on product advertising (Bittner & Schipper, 2014) and what motivates players to play, specifically investigating how different game types perform within this investigation (Hamari & Keronen, 2017). Lastly, this was the year in which we first observed mention of two theories: goal-setting theory (Landers, Bauer & Callan, 2017) and technology acceptance theory (TAM) (Venkatesh *et al.*, 2003). Rutledge *et al.* (2018) could exemplify research that mentions goal-setting theory. It explores how medical educators could benefit from the relationship between gamification and goal-setting theory.

Additionally, a gamified mHealth solution for behavioral change in persons with multiple sclerosis based on goal-setting theory also was developed (Giunti, Mylonopoulou & Romero, 2018). A study counts on TAM to justify the effects of age on technology adoption and use (Koivisto & Hamari, 2014). Moreover, another study (Burkow *et al.*, 2018) used an application to promote exercise training and physical activity in daily life and tried to use TAM to ground it. However, it was unsuccessful since the theory does not consider group, cultural and social aspects of technology acceptance.

The year 2019 produced three clusters. One still focused on exploring individualized gamification, composed mainly by Hamari & Keronen (2017), lately mentioned research on players' motivation. The other two clusters explored healthcare gamification research but from distinct perspectives. While Patel *et al.* (2017a) cluster evidenced literature mainly focused on investigating gamification interventions to motivate physical activity (e.g., Patel *et al.*, 2017b), Deterding *et al.* (2011a) cluster contains a more heterogeneous group of documents, with a remarkable number of those dedicated to reviewing results from healthcare gamification and game-based interventions (Johnson *et al.*, 2016; Cugelman, 2013). 2019 was also the year where the first co-citations relating to prospect theory were observed (Kahneman & Tversky, 1979). An example is a study that trusted prospect theory to theoretically ground a framework for designing and implementing gameful designs in the transportation context (Yen, Mulley & Burke, 2019).

Nevertheless, data from 2020 was able to generate two new clusters. One of them is mainly composed of research on individualized gamification research tradition, suggesting that the subject is getting more relevant among healthcare gamification researchers. Two examples of documents from this cluster are Buckley & Doyle (2017) and Hanus & Fox (2015). While the first recognizes that individual characteristics impact gamification effects and investigates how different learning

styles and personality traits relate to gamified learning interventions, the second proposes a longitudinal study to test and comprehend the effectiveness of specific game design elements (badges and leaderboards) in the educational context. Indeed, isolating game design elements and understanding their personal effects is a gap to be explored within gamification research (Koivisto & Hamari, 2019), and it seems to be an essential step to implementing individualized gamification effectively.

The second cluster is composed mainly of documents that brought up once again the gamification design research tradition, with some contrasts from the gamification design cluster observed in 2013. Documents in the 2020 cluster propose some revised gamification design frameworks by revealing (Koivisto & Hamari, 2019) and consolidating knowledge accumulated in the last years, while offering future research agenda recommendations.

DISCUSSION

The co-citation analysis results can reveal many aspects of the intellectual structure of healthcare gamification. Table 4 summarizes these aspects.

Table 4: Main aspects revealed by year of analysis.

Year	Main Disclosed Aspects		
	Research Tradition(s) Identified	Documents from the Tradition	Central Tradition Document
2012	Game focused literature	4	Gee, (2003)
2013	Game focused literature	4	McGonigal, (2011)
	Gamification design	10	Deterding <i>et al.</i> , (2011a)
2014	General empirical gamification	17	Deterding <i>et al.</i> , (2011a)
2015	General empirical gamification	2	Li, Grossman & Fitzmaurice (2012)
	Education gamification	16	Dominguez <i>et al.</i> , (2013)
	Healthcare gamification	5	Reeves & Read, (2009)
2016	Healthcare gamification	38	Deterding <i>et al.</i> , (2011a)
2017	Healthcare gamification	16	Deterding <i>et al.</i> , (2011a)
2018	Individualized gamification	2	Chen & Wilkosz, (2014)
	Healthcare gamification	58	Deterding <i>et al.</i> , (2011a)
2019	Individualized gamification	2	Davis (1989)
	Healthcare gamification	20	Deterding <i>et al.</i> , (2011a)
		6	Patel <i>et al.</i> , (2017a)
2020	Individualized gamification	6	Buckley & Doyle, (2017)
	Gamification design	22	Deterding <i>et al.</i> , (2011a)

Source: This study.

Considering co-cited documents, Deterding *et al.*, (2011a) assume a notorious position as a central document for 7 of 16 connected clusters. Indeed, this document offers ideal information for authors to cite, allowing it to assume the central position evidenced by our analysis: it offers the most widespread gamification definition (Mora *et al.*, 2015). Other definitions are still verifiable within the co-citation network, as Huotari & Hamari's (2012) proposition observed within 5 clusters. However, none had the co-citation level reached by Deterding *et al.* (2011a), which is also the definition adopted by this research proposal.

Additionally, the continuous citation of Deterding *et al.* (2011a) over the analyzed periods and across different theoretical traditions is another piece of evidence of its relevance to healthcare gamification research. Looking over the primary documents of the 16 clusters, Deterding appeared in 2013 in the gamification design cluster, followed by the 2014 general empirical gamification cluster, from 2016 to 2019 in healthcare gamification classified clusters, and lastly, in the 2020 gamification design cluster.

The second most co-cited document across the analyzed periods was McGonigal's (2011) book, with five appearances in 2 different research traditions. We first observed the game designer book in the 2013 game-focused literature cluster. We also visualized it as providing a supporting role in the 2014 general empirical gamification cluster and the 2015, 2016, and 2017 healthcare gamification clusters.

These verifications appear as an additional conclusion to the analysis built to reveal central research articles within the gamification healthcare domain (Schmidt-Kraepelin *et al.*, 2018). At that point, authors had evidenced the singular Deterding *et al.*, (2011a) influence on the field, alongside other documents that also appeared within this research (e.g., Hamari, Koivisto & Sarsa., 2014; Cugelman, 2013; Koivisto & Hamari, 2014), but had not mentioned Mcgonigal (2011) book.

Based on the publication venues, the analysis revealed that cited documents are published as journal papers (61%), event papers (24%), books (14%), and one magazine paper (1%). Journal papers, specifically, draw some attention. While we observed some documents published in recognized IS journals, like those presented in the senior basket of 8 (AIS, 2011) and the SIGs journals list (AIS, 2011), a considerable number of documents were published in journals outside these lists, such as JMIR Serious Games (5 documents), Computers & Education (4 documents), Pharmacy and Therapeutics, International Journal of Information Management, Personal and Ubiquitous Computing, and Communications of the Association for Information Systems (2 documents each). This evidence may suggest that healthcare gamification literature can be found not only within the traditionally recognized IS reference journals list but in other journals, mainly from medicine and correlated areas, such as psychology.

Lately, within the analyzed database, five theories were found to mainly support healthcare gamification research: flow theory (Csikszentmihalyi, 1975), self-determination theory (Deci, 1971), technology acceptance theory (Davis, 1989), goal-setting theory (Locke, 1968) and prospect theory (Kahneman & Tversky, 1979). Even though these theories were responsible for bringing healthcare gamification research to the actual development level, literature (Putz & Treiblmaier, 2015) points out some opportunities for theorization with the potential to be explored. These opportunities cover, among others, the social cognitive theory (Bandura, 1986), self-efficacy theory (Bandura, 1977), and cognitive absorption theory (Agarwal & Karahanna, 2000).

Research Opportunities

Both the process of conducting and the conclusions originated from this research revealed some opportunities that future researchers in new studies could take:

1. Using the bibliographical coupling technique to reveal references and similarities among different healthcare gamification areas: As co-citation, the bibliographical coupling is a bibliometric technique used to analyze literature. Bibliographical coupling measures the similarity shared between groups of documents by comparing references (Zupic & Čater, 2015). Compared to co-citation, a variable measure that changes over time according to the most referenced documents, bibliographical coupling does not change since it is calculated based on each document reference list. As much as bibliographical coupling is a technique a decade older than co-citation, science mapping more frequently adopts the latter (Zupic & Čater, 2015). Additionally, none of the literature reviews analyzed during the development of our study has considered adopting bibliographical coupling over healthcare gamification.
2. Adopting new, underdeveloped theories to explore its relations to healthcare game design elements: As mentioned, healthcare gamification research has a limited group of theories more commonly adopted: flow theory (Csikszentmihalyi, 1975), self-determination theory (Deci, 1971), technology acceptance theory (Davis, 1989), goal-setting theory (Locke, 1968) and prospect theory (Kahneman & Tversky, 1979).

Putz & Treiblmaier (2015) highlight eleven theories to expand future gamification research. Their suggestion is corroborated by evidence clustered within the co-citation analysis from our literature review. Looking for promising theoretical options to expand the number of theories applied within the gamification research field, we found studies on the cognitive absorption theory. It was a potential option for expanding the gamification research theory canon (Putz & Treiblmaier, 2015). As conceptualized initially by its creators, cognitive absorption is "a state of deep involvement with software that is exhibited through five dimensions: temporal dissociation, focused immersion, heightened enjoyment, control and curiosity" (Agarwal & Karahanna, 2000:673). A gamification theory-based research agenda created by an expert panel indicated that cognitive absorption theory, as well as investigations towards how gamification interventions help to increase cognitive absorption state, is a promising research option (Putz & Treiblmaier, 2015).

3. Continue to investigate the individualized gamification research tradition emerging within healthcare gamification: Even though results lean to be positive, there are still many mixed results when applying gamification to IS (Koivisto & Hamari, 2019). The reality within healthcare gamification research is not different, with plentiful studies obtaining neutral or mixed effects (Johnson *et al.*, 2016).

Poor game design is one of the critical causes of these results, leading to gamified projects that do not fully consider their users' personal needs and fail to fulfill individual preferences through suitable game design elements (Schöbel & Janson, 2018). Indeed, as evidenced by central literature identified from the co-citation analysis developed within our literature review, understanding how individual preferences may impact gamified experiences is valuable knowledge that can better inform gamified system designers in their work (Buckley & Doyle, 2017). Results found within this study indicate that the individualized gamification research tradition seemed to get more evidence in the last few years.

Studies that follow this research tradition, adopting an individualized gamification approach to better comprehend gamification effects on users, may find fruitful terrain to explore.

4. Investigating different types of game elements: Literature points out that "in terms of understanding how gamification works, we are now seeing studies isolating individual design elements, building on theories to derive and test hypotheses" (Nacke & Deterding, 2017:3). Evidence points towards that it usually counts only on points, badges and leaderboards (PBL) as the most common game elements to implement gamified interventions (Koivisto & Hamari, 2019). Nonetheless, literature within the personalized gamification clusters generated from our literature review suggests that gamification research field studies often do not implement controls over the game design elements applied within their gamification interventions (Koivisto & Hamari, 2019). This lack of controls leads to examining results as a whole and not individually, making it impossible to identify which game design element generated specific observed effects (Koivisto & Hamari, 2019). Examples of these situations can be found within Koivisto & Hamari's (2019) review of 66 gamification-controlled experimental studies, in which only 11 studies individually examined game elements.

This study has some limitations. This research is mainly related to the healthcare gamification research context, so we do not aim to generalize findings to a broader gamification research approach. The limitations of our study include the literature review design specific parameters (such as specific databases, algorithms, and thresholds, as co-citation minimum inclusion values). A critical criterion to determine the literature analyzed in our study was the number of citations, which determined which documents were included in specific quartiles, and, consequently, those that were considered and not considered for analysis. We expected that different combinations of such parameters might lead to slightly different results over the same research question.

CONCLUSION

The primary goal of this research was to answer the question: How has the healthcare gamification literature evolved over the years? To achieve this goal, we designed a science map strategy associated with bibliometric methods over a 520-document database.

Research discoveries originating from co-citation analysis strategies lay around unveiling through nine one-year periods ranging from 2012 to 2020 numerous aspects: research traditions, who were the most co-cited authors, and in which publications venues their research was placed over these periods. Additionally, the documents that represent these research traditions were analyzed and depicted. Still, we identified some theories referenced by healthcare gamification research within the database.

Methodologically speaking, the science map strategy demonstrated a suitable way of revealing the healthcare gamification InS. Generated results suggest that healthcare gamification research is a still-evolving research field, with potential research gaps ready for exploration.

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Health-related misinformation sharing on social media in Thailand: A case study during the Covid-19 pandemic

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ABSTRACT

Misinformation affects people because it can convince them to believe in how to respond to uncertain situations. During the COVID-19 pandemic, a number of misinformation or fake news were distributed on social media, in Thailand. This research aimed to study attributes and causes of Health-Related Misinformation Sharing in Thailand on social media during the COVID-19 pandemic. Dataset used in this study was collected from the Anti-Fake News Center, the Thai government fact-checking website certified by the International Fact-Checking Network (IFCN). In-depth interviews based on qualitative research technique were also conducted to identify the causes of the transmission of false health news on Thai social media by applying the rumors transmission concept during times of crisis and the theory of Uses and Gratifications. The findings showed five main themes of fake news: conspiracy theories, pseudoscience, fake advertisements, inaccurate information, and misleading information. These elements may establish a conceptual framework for finding the root cause of misinformation spreads during crises. Factors that affect how psychological information was presented and shared are anxiety, insecurity, and uncertainty during the crisis. However, belief is not the only justification for sharing this information because some social media users have shared unverified and no evidence information for personal purposes. The Uses and Gratifications theories are found relevant. This study is intended to broaden the reach of disseminating misleading information as much as possible to lessen the effect of detrimental health fake news on Internet news consumers.

Keywords: Misinformation, Disinformation, Fake News, Covid, Health.

INTRODUCTION

Fake news significantly impacted Thai society when the Coronavirus Disease 2019 (COVID-19) outbreak began. As COVID-19 was new, there was a lack of relevant information on disease control management, preparation, and prevention, causing fear, confusion, and misinformation. The spread of misinformation, however, had generated huge negative impacts on society. It has been studied that spreading misinformation about vaccine safety affected population immunity rates (Borah, Kim, Xiao, & Lee, 2022). The spread of misinformation and fake news about viruses, their origins, vaccines, and treatment methods can be called Infodemic (Gisoni *et al.*, 2022). At the WHO meeting in Munich, Germany, on February 15, 2020, Dr. Tedros Adhanom Ghebreyesus, Director-General of the World Health Organization (WHO), addressed the fake news problem. "We are not just fighting and epidemic; we are fighting an infodemic." The sentence was further explained by Sylvie Briand, Director of the Global Infectious Hazard Preparedness department (GIH) at the World Health Organization's (WHO) headquarters. She explained that the World Health Organization and the global health system are facing an information crisis because in the social media era, information spread as fast as a virus does. The spread of information also contains inaccuracies, rumors, and other information. Dealing with misinformation sharing is thus a new challenge which requires quick responses. To minimize the negative impacts, people must be provided with correct information that will help them deal with incidents appropriately (Zarocostas, 2020).

The dissemination of health misinformation on media platforms has affected a global health crisis as it directly and negatively affects the perceptions, decision-making and responses of those who believe in the misinformation (Bolsen, Palm, & Kingsland, 2020; Hansson *et al.*, 2021). For example, those who believe in fake news about COVID-19 vaccine may decide to not receiving vaccine and later on may face health issues that could have been avoided or prevented by the vaccine. In addition, the speed of (mis)information dissemination have been increased tremendously via the Internet and social media. Therefore, it is necessary to study and understand this phenomenon in order to deal with fake news sharing and its consequences.

This research aims to study the spread of fake news in Thailand by analyzing fake news content collected from government anti-fake news centers according to a 6-step thematic analysis as follows: (1) Familiarization with the data, (2) Initialization, (3) Searching for the essence, (4) Re-examination of the subject, (5) Identifying and naming the essence, and (6) Formation Report (Braun & Clarke, 2006). The attributes of fake news identified in the first phase of this research will be used to further understand fake news sharing behavior and reasons through in-depth interviews. Two research questions are: RQ1) What are characteristics of health-related misinformation that were spreaded on social media in Thailand during the outbreak of COVID-19?; RQ2. Why did people share health-related misinformation on social media in Thailand during the outbreak of COVID-19?

LITERATURE REVIEW

Fake news and Anti-Fake News Center in Thailand

Fake news has become a hot topic since the 2016 US presidential election. In the final campaign of the election, 8,711,000 electoral information was disseminated (Silverman & Singer-Vine, 2016). Two essential attributes, namely the authenticity of the content and the intent of the news, define fake news. The content of fake news contains false information with the fraudulent intention to deceive or distract audiences (Allcott & Gentzkow, 2017). Fake news is used interchangeably with misinformation in some studies. According to Lazer et al. (2018) fake news is fabricated information that mimics the form of mainstream news media content but not the editorial process. However, Gisondi et al. (2022) noted that misinformation is misinformed but has no malicious intent, different from fake news. Rather, disinformation is intended to spread misinformation with malicious intent (Gisondi et al., 2022). Wu et al. (2019) explain that fake news refers to false information in the form of communication. It differs from misinformation because publishers may be news consumers who do not intend to deceive but genuinely believe the news (Wu et al., 2019). False information is considered misinformation, which is incorrect information that usually occurs during the development of an event, or additional information over time that is not for convincing or misleading guided purposes (Kumar & Geethakumari, 2014; Scheufele & Krause, 2019). Disinformation is false information intentionally guided by the publisher's objectives (Fallis, 2009; Stahl, 2006).

In Thailand, the Ministry of Digital Economy and Society established the Anti-Fake News Center on November 1, 2019, to provide Fact-Checking Website services according to international standards of the International Fact-Checking Network or IFCN (<http://www.antifakenewscenter.com/>). Thai people can submit news information they want to check on this website. Officers will review relevant sources of news content and update facts on the website within 2 hours in coordination with the Police Cyber Taskforce (PCT) of the Royal Thai Police. The Anti-Fake News Center does not provide a clear definition of fake news or a description of the scope of fake news content on its website. Rather, it covers the wide range of fake news. It focuses on the Covid-19 news with inaccurate information that affects four groups of problems in Thailand: disaster, economy, health-related products, and government policy (Sombatpoonsiri, 2021). This research will collect all types of fake health news collected from the Anti-Fake News Center websites. It will be consistent with the actual situation in Thailand. Today, the scope of fake news has expanded beyond the original definition due to the complexity of the Internet and social media. However, fake news started to gain attention after being used in political contexts and becoming widespread in many other contexts—for example, vaccination, nutrition, stock exchange, and other aspects. Fake news poses a severe threat to mainstream media systems, especially regarding credibility (Lazer et al., 2018).

Rumor Transmission

Rumors refer to unverified news that can be both true and false (Wu et al., 2019). Sun et al. (2020) researched the transmission of health rumors among the elderly in China during the COVID-19 outbreak in 2020 and found that the belief that the information submitted was accurate positively related to the willingness to pass it on among older adults during the COVID-19 pandemic. In addition, personal anxiety was negatively associated with the ability to discriminate against rumors and perceive the consequences of spreading rumors (Sun et al., 2020). Prasad (1950) explained that natural events could cause fear. For instance, earthquakes will cause emotional disturbances, and attitudes will broaden widely. Ambiguity related to lack of evidence, and anxiety was crucial for spreading rumors. Emotion plays a big part in the growth of stories. The power behind words will fade away once it is gone. Rumors arose to satisfy the need for an explanation. Rumors are drawn from the famous stories among the group to perceive the event. It would be close to the need for control to predict future events. Rumors that cannot be easily verified will persist and continue to spread (Bordia & DiFonzo, 2002; Prasad, 1935, 1950). Spreading rumors depends on the importance of content and ambiguity for further spreading (Allport & Postman, 1947; Bordia & DiFonzo, 2002). Rosnow's research (1991) found that anxiety and belief that rumors are true and uncertainty in current or future situations can predict the spread of rumors (Rosnow, 1991). Its response to feelings of threat (Difonzo, 2018). Suspicion and distrust of official announcements or news can cause rumors (DiFonzo & Bordia, 2000).

Uses and Gratifications Theory

The use and gratification theory is the most widely acknowledged and frequently adopted concept in journalism to explain reasons and motives of media consumption. (Kaur, Dhir, Chen, Malibari, & Almotairi, 2020; Vickers, 2017) The Internet and social media have recognized and studied as the new and popular media (Papacharissi & Rubin, 2000; Whiting & Williams, 2013). The study of motivation to transmit social media information was often based on a personal basis. Prior literature, which adopted use and gratification theory to explain why users share information on social media, identified four main reasons: entertainment, socializing, information seeking, and self-expression (Chen, Sin, Theng, & Lee, 2015). Chen et al. (2015) applied the Uses and Gratifications theory to their study of data characteristics and rumors spread by questioning Singapore university students on the reasons for spreading misinformation on social media. The top three reasons for student

transmission of misinformation are that the information can be a good topic for conversation, interesting, and new eye-catching details. The fourth-ranked reason is sharing information helps them get to obtain opinions of others about the news. The reason that the students (senders) can express their opinion by sharing that information is ranked fifth. On the other hand, the accuracy of the data ranked 24th out of 29 topics, and the reliability of the data source ranked 26th. This implies that the students did not pay attention to the accuracy and reliability of the information they shared. In terms of gender difference, the study found that more women shared misinformation than men did. Significant differences in the rank of reasons for sharing were also found in 10 out of 29 reasons. Overall, main reasons for sharing information on social media were: they shared to bookmark helpful information; they shared to enhance interpersonal relations; they shared to keep updated on the latest happenings; they shared to stay in touch with friends; they shared to get other related information; they shared to relax; they share fun information.; they share as others do; they shared for enjoyment; they shared to interact with people (Chen et al., 2015).

METHODOLOGY

Research Methods

This research examined the characteristics of inaccurate health information in Thailand as factors related to motivation and reasons for misinformation transmission. The research was divided into two phases: 1) classification of fake news attributes and 2) investigation of behavior and reasons for fake news sharing. In the first phase, we attempted to understand and identify attributes of fake news related to health issues in Thailand through thematic analysis. In the second phase, a semi-structured interview was employed to understand motivation or reasons to share fake news. Interview was considered an appropriate method to understand complex and sensitive issues. In addition, semi-structured interviews allow respondents to answer question freely but in-depth and to the point (Figueroa-Domecq, Pritchard, Segovia-Pérez, Morgan, & Villacé-Molinero, 2015; Hankinson, 2009; Jones, Brown, & Holloway, 2012).

Data Collection and Analysis

In the first phase, we attempted to study the phenomenon of fake news related to health in Thailand and identify their attributes. We collected 468 fake health news listed from November 1, 2019 to January 24, 2022 on the Anti-Fake News Center's website. It is an official fact-checking website, in Thailand, which follows the international standards of the International Fact-Checking Network (IFCN). To analyze the collected fake news, we followed the study of Mohammadi et al. (2022), which investigated misinformation about COVID-19 from fact-checking websites, by adopting the Framing theory as a framework for thematic analysis. According to Mohammadi et al. (2022), framing theory posits that a message can impact public's opinion, behavior, and actions differently, depending on how it is framed. The theory is helpful because it can reflect the motivations and goals of the messengers well (Entman, 2006; Mohammadi, et al., 2022; Weaver, 2007). The six-step thematic analysis (Braun & Clarke, 2006) method were followed. Two investigators used a six-step thematic analysis to: 1) familiarize with the data, 2) initialize, 3) search for the essence, 4) re-examine the subject, (5) Identify and name the essence, and (6) form a report. The thematic analysis is a popular analysis method used in research about 'framing', because it can identify similar and dissimilar data attributes (Allen, 2017; Thompson, 2014). The analysis of the apparent main themes was reviewed again to identify a subtheme to reduce coder bias. Cohen kappa statistics were then calculated to estimate Inter-rater reliability (IRR) to indicate the relative significance of appraisal rates (Landis & Koch, 1977). Miles and Huberman (1994) suggested that an acceptable IRR higher than or equal to 80% was 0.8. As McAlister et al. recommended, if the IRR was higher than or equal to 80%, it was acceptable (McAlister et al., 2017).

In the second phase, we attempted to understand fake news sharing behavior and reasons by interviewing people who shared fake news. Therefore, the samples for this study must be those who used to share inaccurate health information. The samples were selected by purposive sampling in combination with the snowball technique. Twenty one samples agreed to participate in a semi-structured interview session, which would take about 40-45 minutes. The interviews, however, were conducted through telephone, due to the COVID-19 pandemic lock down and social distancing constraints. See Table 1 for information about the interviewees. In this phase, we have learned from the first 6 respondents that the word 'fake news' was offensive and people would reject that they shared fake news. However, if we provided examples of fake news headlines, they would then realize and admit that they had shared the fake news. Therefore, to reduce the interviewees' self-defense, we avoided using 'fake news' and using 'misinformation' instead. This approach was based on a method of interviewing rape-sensitive questions by avoiding rape in Africa but using behavior-specific questions. For example, non-consensual intercourse because it had a better outcome for confirming rape behavior (Sikweyiya, Jewkes, & Morrell, 2007). The first 6 respondents connected us to the other 15 respondents. The 21 samples were aged 37-71 years. Half of the group were retired. The percentage of retired persons was high as Thailand has now entered an aging society (Tejativaddhana, Chuakhamfoo, & Vo, 2022). All interviews were recorded and transcribed. The six-step thematic analysis (Braun & Clarke, 2006) was applied by two coders to identify fake news sharing behavior and reasons. As in the first phrase, the Cohen kappa statistics were used to assess Inter-rater reliability.

Table 1: Interview respondents' Profiles.

Case	Age	Gender	Education	Location	Infection	Covid's knowledge	Career
1(Pilot)	59	female	PhD	urban	infect	fair	professor
2(Pilot)	67	female	Master	rural	clean	fair	retiree
3(Pilot)	62	female	Master	urban	clean	good	retiree
4(Pilot)	56	male	Master	urban	clean	fair	retiree

Case	Age	Gender	Education	Location	Infection	Covid's knowledge	Career
5(Pilot)	67	female	Master	urban	clean	good	retiree
6(Pilot)	45	female	Master	urban	clean	fair	employee
7	47	male	Master	urban	clean	good	official
8	53	male	Bachelor	urban	clean	good	freelancer
9	69	female	PhD	rural	clean	fair	retiree
10	65	male	Bachelor	rural	infect	fair	retiree
11	62	male	Master	urban	infect	fair	retiree
12	71	male	Bachelor	urban	clean	good	retiree
13	42	female	Bachelor	rural	clean	good	official
14	48	female	Bachelor	urban	clean	good	official
15	60	male	Bachelor	rural	clean	fair	Insurance Agent
16	60	female	Master	urban	clean	fair	retiree
17	60	female	Bachelor	rural	infect	good	official
18	63	female	Bachelor	urban	infect	fair	retiree
19	61	female	Bachelor	urban	clean	fair	retiree
20	54	female	Master	urban	clean	good	freelancer
21	37	female	Master	urban	infect	good	official

Source: This study.

RESULTS AND DISCUSSIONS

In the first phase, two coders have coded 468 fake news collected from the website of Anti-Fake news Center, Thailand. Inter-rater reliability (IRR) for each news had an IRR value between 0.8 and 1, which are within acceptable range. Five main themes are identified as attributes of fake health news shared in Thailand during the COVID-19 pandemic.

Attributes of fake health news in Thailand

Five main themes are classified, including Conspiracy theories, Pseudoscience, Fraudulent advertising, Incorrect information, and Misleading information. Fourteen subthemes are identified, as shown in Table 2. Subtheme, such as Easy to follow Treatments, has similar characteristics to the theme, called Protection and solution, identified in Mohammadi et al. (2022). According to Mohammadi et al. (2022), protection and solutions relate to home remedies, treatments, drugs, diagnosis and testing, and virus killers. The identified themes in this study are also consistent with the findings by Wonodi et al. (2022), who studied misinformation in Nigeria, such as biological weapons transmitted by 5G technology.

Table 2: Identified COVID-19 misinformation themes and subthemes.

Subthemes	Code	Examples	Count	% Codes
Conspiracy theory theme				
There is someone behind it.	CT01	To take control of Thailand, communist terrorists collaborate with pharmaceutical corporations to insert viruses into vaccines that will inject into Thais people.	17	1.30%
An insider told me.	CT02	The medical authorities would tell each other but not say to the public.	125	9.70%
There are plans to cover up negatively against the public.	CT03	The government hides the truth because it fears people will not be vaccinated. The number of people who have died from vaccination is now close to 100.	64	5.00%
Paranoia.	CT04	Pfizer or Moderna vaccinators can now prepare to farewell their families because these people will die within two years.	46	3.60%
Connect the dots but no supporting evidence.	CT05	Smelling solid herbs can kill all kinds of germs.	66	5.10%
Misleading information theme				
Intentional misinformation	ML01	The military has spent 22 million to spray disinfectants on the roads.	216	16.70%
Try to convince	ML02	The infected patients escaped from the quarantine!!!.... They smashed the walls to escape.	195	15.10%
Create confusion	ML03	When you have registered to reserve a vaccination, you must check with the hospital in 7-10 days because your reservation can be missed.	181	14.00%
Fraudulent advertising theme				
Fraudulent	FA01	https://www.moqh.in.th/?rid=G8YsMuq Ministry of Health Register for Covid-19 vaccinations	40	3.10%
Scam review	FA02	When I discovered that a member of my household was infected with	54	4.20%

Subthemes	Code	Examples	Count	% Codes
		COVID, I ordered xxx to take it out early. I was infected with coronavirus when I went to the hospital for a check-up. Now, I'm hospitalized, and my condition is getting better. My lungs are normal, no fever, and my breathing is as good as before.		
Incorrect information theme				
Incorrect information	II01	The covid-19 vaccine is made from pork fat.	67	5.20%
Pseudoscience theme				
Scientific reference	PS01	A person's emotional state affects the transmission of the COVID-19 virus. The more negative emotions, the more easily infected.	33	2.60%
Give the audience hopeful information.	PS02	GOOD NEWS* Finally, Ram, an Indian student, has found a generic home remedy for *Covid 19* that has been approved for the first time by WHO.	86	6.70%
Home remedies and Easy to follow Treatments.	PS03	To maintain body temperature and avoid disease, drink enough hot water. Infection can be avoided by eating ginger and working out frequently.	100	7.80%

Source: This study.

Conspiracy theory theme **There Is Someone Behind it**

The attribute of the Incorrect information checked by the anti-fake news center related to any actions by an influential person or group without evidence is grouped in this category. Heider explained in 1958 that conspiracy theories were to describe events. It played an essential role in ensuring internal stability and consistency. Most were characterized by solid and dangerous groups' significant events and secret plots (Douglas, Sutton, & Cichocka, 2017; Goertzel, 1994; Heider, 1958). Some keywords show prominent features. Details can be found in Table 3.

Table 3: Identified keywords in There Is Someone Behind its subthemes.

Pattern	Examples keywords
Actors	Terrorists; Communists; Global Trash; Pharmaceutical Companies; Vaccine Sellers; Participants; The Chinese Government; Wuhan; In China; Lab; United States; Orders From Above; Prime Minister; VVIP, Etc.
Action	Intervened; Criterion; Strike As; Gesture; Claim; Force, Order; Choose To Give; Stop Administration; The Reason Is, Etc.
Reason	Genocide; Ordered To Shoot; Occupy Thailand; Take Advantage; Test Drugs; Transmit The Covid-19 Pathogens; Infect; Quarantine Patients; Do Not Pay; Sell Vaccines, Etc.
Result	Penalty; Impact; Abandoned To Their Fate; Lack Of Income; Terrible; Its Cruelty, Etc.
Warning	Don't Tell Anyone; The Whole World Will Know; Detect; They Are Scared, Etc.

Source: This study.

An Insider Told Me

The attribute of Incorrect information checked by the anti-fake news center or the fact-checking website related to any content that the messenger refers to as an insider source without evidence is grouped in this category. The motivation for rumor transmission would likely have caused the need to search to fill incomplete or conflicting information to reduce uncertainty and doubt in describing the event without patterns. The description of the event might contradict one's beliefs. Conspiracy theories deal with threats through the transmission of uniquely structured information. On the other hand, it was a reference to recognized insiders and outsiders trying to harass with details of how and why the harasser uses and the insider's countermeasures (Douglas et al., 2017; Tangherlini, 2017). Defining insiders and outsiders was essential for studying narratives, beliefs, social theories, and conspiracy theories (Barkun, 2003; Bodner, Welch, & Brodie, 2020). Some keywords show prominent features. Details can be found in Table 4.

Table 4: Identified keywords in An Insider Told Me its subthemes.

Pattern	Examples keywords
Celebrity	Fauci; Robert F. Kennedy Jr.; Bill Gates; Dr. John; His Royal Highness Ordered (Queen Of Thailand); Last Night, I Dreamed Of Luang Pu Tuad (A Famous Monk); Professor Dr. Prasit (A Renowned Doctor); Mr. Anutin (Ministry Of Public Health), Etc.
Friends and Family	My Friend's Telephone To Tell Me; My Grandchildren Called To Say To Me; My Friend's Mother Is A Doctor Who Is Going To Respond To This Case; My Mother Sent A Message To Me Via Line; My Aunt Said; My Mother Said; My Colleague's Mother Told Me; My Sister Who Has Been Examined There Hear An Urgent Announcement A Moment Ago; My Friend's Granddaughter Has A Master's Degree And Works In China; I Just Listened To The News From Someone Close To Me; From A Respected Senior; A Senior At Work Told Me That; My Senior Who Is The Owner Of Tour Company Already Has It; The Co-Workers Told Me; News From My Mom, Etc.
Authority	The Government Announced; The Live Broadcast From The Office Of The Permanent Secretary Of The

Pattern	Examples keywords
	Ministry Of Public Health Announced; From Facebook Live Ministry Of Public Health; The Source Is From Bamrasnaradura Infectious Diseases Institute; Coronavirus Disease 2019 Press Conference, The Emergency Operations Center For Medicine And Public Health; The Department Of Thai Traditional And Alternative Medicine Reveals, Provincial Public Health Office Assessment That; Consul Accepted That Etc.
Organization	A Retired Former Pfizer Executive; Said Pfizer's Former Science Chief; Pfizer Scientists State That; The Billionaire Co-Founder And Binding Force Behind The Covid-19 Vaccine Call For; World-Class Nuclear Physics Scientists, A Group Of German Doctors Found; Internationally Acclaimed Immunologist Continues; According To Italian Scientists; Division Of Chinese Medicine And Chinese Herbal Medicine; Chinese National Medicine Division, The United States Supreme Court Ruled That Foreign News Releases; The Japanese Government Found; The British Public Health Officials Said; Doctors Around The World Issue Urgent Warnings, Etc.

Source: This study.

There are plans to cover up negatively against society or groups

The attribute of Incorrect information checked by the anti-fake news center or the fact-checking website related to any actions covered by an influential person or group without evidence is grouped in this category. A key attribute of conspiracy theories is the speculation that some activities are behind the public perception. It requires complex multi-party cooperation. Those accomplices will lie and deceive the public by transmitting misinformation to cover up their efforts (Douglas et al., 2017). Some keywords show prominent features. Details can be found in Table 5.

Table 5: Identified keywords in There Is Someone Behind its subthemes.

Pattern	Examples keywords
Hidden actions	Covered; Hush News; Order To Hush; Confidential Report; Cooperate To Hush Up The News; No Report; Not Informed; Never Disclosed; Pretext; Lie, Deceit; Silence; Suppressed; Secret That Stops The World; Do Not Tell; Do Not Have; Avoid, Edit; Delete The Numbers; Are Created, Etc.
Force action	Ordered; Forbid, To Demand; Be Ordered; Not Permitted; To Stop, Do Not Access; Without Orders; Be Caution; To Tell; Decide; I Can Say Only This; In Trouble; Merciless, Etc.
Expose action	To Expose; Leak; Rumor; Hear The News; Spread The Word; Sound; Waiting For Him To Announce; Report; Publish; Note; Disclose; Occur; Take-Out Accept; Indicate; Or Expect Because There Will Be; The Reason Is; It Is Essential; I Know That; Will Know; Know Information; Access; Let See; He Knows; Warn Me; Be Cautious, Etc.
Fear	Impact; Fear; Fear That People Will; Because There Will Be; Panic, Embarrassed; Angry; Cursed; Worried; Be Careful; Do Not Want, Etc.

Source: This study.

Paranoia

The attribute of Incorrect information checked by the anti-fake news center or the fact-checking website related to any actions that messenger feels insecure of information without evidence is grouped in this category. Belief in conspiracy theories is linked to narcissism. It is a defensive motive to alleviate the bad feelings of one's or one's group due to their unfavorable status to access information. It is an extension of personal perspective that requires external validity and is connected to paranoid thinking (Cichocka, Marchlewska, & De Zavala, 2016). some keywords show prominent features. Details can be found in Table 6.

Table 6: Identified keywords in Paranoia subthemes.

Pattern	Examples keywords
Violence	World War; Biological Weapons; Reduction Of The World's Population; The Genocide Of Thai People; Destroying People All Over The World; Crime; Countless Deaths; Killing People; People Will Die; Kill People Indirectly; For Security; Full Of Germs; Facilitating The Insurance Group; Lethal Poison; Poison; Injected; Arrested; Dangerous Virus; New Virus; Diseases; Germs; Genocide Vaccines; Dangerous Vaccines; Death Vaccine; Non-Vaccination; Vaccination; Genetic Modification; Genetic Material; Genetic; It Is A Hoax; Lowers Immunity; Inject Virus; Carries Viruses, Etc.
Anxiety	Does Not Share News; Do Not Go Out; Refrain From Entering; Refrain From Going; Escape; Protect People; Protect Yourself; Fight For Existence; Be Careful; Be Careful With Yourself; It Is A Mistake; There May Be A Problem; Stop Vaccination; Don't Inject; We Do Not Inject, Etc.

Source: This study.

Connect the dots but no supporting evidence.

The attribute of Incorrect information checked by the anti-fake news center or the fact-checking website related to any information without evidence is grouped in this category.

Misleading information theme

Intentional misinformation.

The attribute of Incorrect information checked by the anti-fake news center or the fact-checking website related to any information intended to present false information to news consumers without evidence is grouped in this category. The European Association For Viewers Interests (Eavi) presented a type of news that deliberately misrepresents information into ten main categories. It avoids using the term fake news in article headings because it requires complexity. The meaning of the word fake news can be confusing. Thus, it can lead to the fact that their only real and fake news. Instead, they use the term misleading news, further information intended to create confusion. Still, the primary purpose is mainly for money and power, and other purposes, such as global warming news, may be made for political reasons (Steinberg, 2017).

Try to convince.

The attribute of Incorrect information checked by the anti-fake news center or the fact-checking website related to any information intended to make believed or convince news consumers without evidence is grouped in this category. Some keywords show prominent features. Details can be found in Table 7.

Table 7: Identified keywords in Intentional misinformation subthemes.

Pattern	Examples keywords
Arousal	In the shocking announcement; Shocking!!!; Checked the covid red zone here!!; We win; Covid Insurance only covered who got lung infected; Now, the Emergency room is currently indefinitely closed; The body is forbidden to open already in the bag; Dangerous Covid zone by the Ministry of Public Health; If you don't want to sleep forever like this, please take care yourself, etc.
Condemn	Expensive and low quality still, they will buy more; They don't care about us, only care about their life; Death will be forbidden or delayed, etc.
Attention	There is news that; There is a rumor that all family got infected; I have the information you should know, etc.
Convincing	Official results confirmed; I advise everyone to do their research; Most of it is their opinion, etc.

Source: This study.

Create confusion.

The attribute of Incorrect information checked by the anti-fake news center or the fact-checking website related to any information intended to confuse news consumers without evidence is grouped in this category. Some keywords show prominent features. Details can be found in Table 8.

Table 8: Identified keywords in Create confusion subthemes.

Pattern	Examples keywords
Questioning	Is this message valid; Is anyone know? Please tell me the details; I will find the fact for you later; Let's think about how an escaper will be entered; Anyone who knows this, please explain, etc.
Informed	I cannot explain to make you guys believe me, but...; People who do not get vaccinated will be prohibited; Rumor that they found...; I can tell that we must prepare for it!!; Some people leave field hospitals without lung checkups; I see someone collapse at an intersection; Just got vaccinated and now died; You should see this, etc.
Sarcastic	They donate vaccines for free, but Thailand doesn't take them. Why; If they had a gut, I would take a risk, etc.
Asking	Please share; Help ourselves and other people in the world; Listen to this, and please share; please be careful, etc.

Source: This study.

Fraudulent advertising theme

Fraudulent

The attribute of incorrect information checked by the anti-fake news center or the fact-checking website related to any information intended to trick news consumers, such as phishing links, is grouped in this category.

Scam review

The attribute of incorrect information checked by the anti-fake news center or the fact-checking website related to any information with a commercial purpose is grouped in this category. Hu et al. (2012) explained that a fake review is an act of a manufacturer, seller, or third party to pursue a product review and deliberately disseminate untrue information to portray itself as a consumer increased sales and benefits.

Incorrect information theme

The attribute of incorrect information checked by the anti-fake news center or the fact-checking website related to false information is grouped in this category. Misinformation is a mixture of accurate and inaccurate information. It is intended to disseminate information, but the messenger does not know that it is misinformation and therefore has harmful effects on society (Steinberg, 2017).

Pseudoscience theme

Scientific reference

The attribute of the incorrect information checked by the anti-fake news center related to any content that the messenger refers to as a scientific source or scientist without evidence is grouped in this category. Blancke et al. (2017) explained that what makes a scientific concept accepted or rejected is related to trust in the data. Citing experts is integral to everyday convictions and decisions, such as going to the dentist or choosing a garage (Blancke, Boudry, & Pigliucci, 2017). Science is helpful because it aligns people's instincts rather than scientific reasons that contradict intuition (Boudry, Blancke, & Pigliucci, 2015; McCauley, 2011; Wolpert, 1992).

Give the audience hopeful information

The attribute of the incorrect information checked by the anti-fake news center related to any content that provides an optimistic or untrue solution for the receiver without evidence is grouped in this category. False hope has a mental value that leads cancer patients and their families to misinformation in a world-false science model that advertises unsubstantiated treatments. These data will pledge that many people have recovered and lived long, healthy lives despite being told by doctors to go home and wait for the day of death. The data, consisting of medical conspiracy theories, is designed to advertise natural methods or more dramatic treatments (Bernicker, 2019).

Home remedies and easy-to-follow treatments

The attribute of the incorrect information checked by the anti-fake news center related to any content that provides easy methods to follow to improve health without evidence is grouped in this category. This irrational belief drives the direction of illogical science. Pseudoscience is linked to the confirmation bias that causes most people to favor scientific theories that are easily understood and reasoned based on their ideas, not truth-based reasoning, and when pressured to make decisions or feel burdened, look for reasons that support their arguments by ignoring such assertions, which this motivation makes it impossible to consider the value of conflicting information (Mercier & Sperber, 2011).

Causes of health-related fake news transmission

According to phase 1 of this study, there is a growing spread of health rumors related to pandemic response guidelines and ways to behave. The conspiracy theory theme has characteristics that are seen in their fabricated pattern. The transmission of fake news is composed of messengers and receivers, with the transmission of information on social media usually intended to attract the attention of the recipient, so the use of arousal and moral words such as 'fight,' 'greed,' 'evil' and 'punish' assembled in the message will make the messenger pay attention to receiving information and increase the chances of forwarding it (Brady, Gantman, & Van Bavel, 2020; Brady, Wills, Jost, Tucker, & Van Bavel, 2017; Han, Cha, & Lee, 2020). Based on the interviewee's answers in phase 2 of this study, 11 out of 15 respondents believed that people who share fake news believe that the information they share are true/correct.

One of the interviewees, a retired doctor who worked during the H5N1 pandemic as an executive administration of the public health ministry, explained, "If they share fake news, it will ruin their reputation. Nobody in my group chat intends to share fake news. They did that by mistake." He does share health news a lot. "I want to warn everyone in my circle about important information. If it is true, it will benefit them, I want to share some knowledge that I think is accurate."

Another interviewee is a doctor who works at a province hospital and believes that "Nobody has an intention to share fake news." She, however, admitted that she used to share fake news. "I cannot remember correctly, but I shared some misinformation from unofficial Facebook pages."

7 of 15 respondents perceived the benefit of health information sharing. "I shared some useful news with my family to inform them."; "If I think that's useful, I send it to all of my group chat sometimes twice."; "I think they share new information because they want to inform others for their benefit."

10 of 15 respondents thought that people who shared fake news felt insecure about the pandemic. "I don't want to aggravate the terror that already exists."; "I think they were worried and believed that everybody should protect themselves; they do care."; "I believed they were panic."; "I already inform them, true or not; if it helps, I will share."; "I think fake news sharing has been increased because people cared about their close ones."

9 out of 15 respondents think people do not check the information they share before posting it. "They shared without investigation."; "Nobody knows what was right or wrong because it was so new."; "I shared fake news because the evidence seemed real."; "Some of my group chat was such random trash about Covid-19 news"; "They didn't have critical thinking." However, 9 of 15 respondents also admitted that it is possible that some people gained benefits from fake news sharing. "It's possible that vaccine companies may send fake news to attack their competitors."; "It's all about business."; "Everyone was forced to get a vaccination, but they only cared about the benefit, not people's life"; "They do care about engagement data."

CONCLUSIONS

This study expanded the understanding of misinformation in Thailand by classifying attributes of health-related fake news. Five main themes, showing visible patterns of words or terms that intend to attract news consumers' attention, are Conspiracy theories, Pseudoscience, Fraudulent advertising, Incorrect information, and Misleading information. The conspiracy theory

theme shows an unmistakable pattern of rumor transmission. The COVID-19 outbreak has significantly increased conspiracy theories, rumors, and news that have fueled scientific distrust on social media (Mukhtar, 2021). Conspiracy theories are a type of rumor because the critical feature of rumors is information that has not been supported or proven true. It might also be called a conspiracy rumor. This type of rumor is characterized by the covert and malicious activities of the dominant secret group (Difonzo, 2018). The spread of fake news is the result of an outbreak of news. Consequently, anxiety and confusion escalated to many levels due to fear and the inability to trust the accuracy of public information. It may also lead people to believe suggestive non-scientific details such as the dangers of medicines or the origins of COVID-19 (Rodrigo, Arakpogun, Vu, Olan, & Djafarova, 2022).

LIMITATION

This study was conducted in Thailand, with only one fact-checking website that was certified by international standards of the International Fact-Checking Network IFCN. This study analyzed the incorrect information checked by the anti-fake news center 468 news from November 1, 2019, to January 24, 2022.

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How does Covid-19 disrupt traditional success models: The case of e-learning

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ABSTRACT

This paper questions the prevalent approach in assessing the value of e-learning through the information system model. A recall is made of the evolution of DeLone and McCain model and other theory at the basis of such assessment, namely TAM derived models and performance models. In these years of covid which imposed e-learning on schools, without adequate preparation this examination is more than ever important since it changes the logic of the assessment. The covid19 caused an involuntary use of e-learning that questions the validity of prevalent models. An integrated model, which take this aspect into consideration, is proposed in this article, to be validated empirically in a soon future.

Keywords: Covid-19, Delone and McLean, IS success model, e-learning, performance, satisfaction, e-readiness, teacher readiness.

INTRODUCTION

Lately, several newspapers have reported on the deaths of young people engaged in e-learning due to Covid-19. They took their own lives because they could not deal with the stress of online sessions (Nath, 2020). Many experienced on-line learning difficulties or technological functionality problems (Recana, 2020). This, namely, suggests that the decision to generalize e-learning approach, advocated as the only solution and introduced wall-to-wall as a global response to the pandemic crisis should be revisited since it may pose problems (Taravulea *et al.*, 2020), namely (but not only) in regards of student mental health and student confidence to get a job degree and a job based on the credibility of this one (Mohapatra, 2020).

E-learning adoption is not a new phenomenon. Along with a pedagogical battery of tools such as active learning, flipped classrooms, 21st century skills development, artificial intelligence, virtual reality, etc., e-learning has today achieved a huge sales market (Koksal, 2020). The main advantages of e-learning are well known, namely, easier access to learning and flexibility over time and space, enhanced and empowered learning, time savings, improved and faster feed-back (Holsapple & Lee, 2006; Ismuratova, 2020; Ng *et al.*, 2020; Popa, 2020). In their systematic review, Choudhury & Pattnaik (2020) provide an exhaustive list of 43 such advantages from several points of view (i.e., from students', teachers', institutional and societal perspectives).

These advantages are mitigated by some negative aspects. These include social isolation, quality concern (Hodges *et al.*, 2020) and other disadvantages such as limited feedback, difficulty in preventing cheating, limited adaptability for some disciplines, teachers favouring theory over practice, requiring e-readiness from students (Tamm, 2019). From a review of 138 articles, Choudhury & Pattnaik (2020) add ten more disadvantages, namely, transactional distance, misinterpretations, lack of body language, digital divide, lack of cohesiveness and connection between students, and blurring the difference between school and home.

The move to emergency online teaching due to Covid-19 also added many challenges; the suddenness of its introduction, the burden it brought on schools' management, the disruption of existing pedagogy and the lack of concern for the consequences for students and for teachers, with many having to improvise online teaching solutions with limited help and guidance from their schools (Bao, 2020; Green, 2020; Hodges *et al.*, 2020; QS, 2020; Elkhannoubi *et al.*, 2022). Teachers were expected to redesign their courses almost overnight. Many did not have sufficient time, energy or knowledge to do so adequately. Mandatory social distancing measures and temporary physical closures of school also meant that students were forced into

online classes (Cheong et al., 2020; Greene, 2020; Mohapatra, 2020). Even teaching institutions were unprepared and experienced many difficulties in supporting online student assessment alternatives (Sharadgah & Sa'di, 2020).

During the pandemic, e-learning was implemented suddenly, in response to the need to provide education to all students, eliminating their physical, in-class presence. To continue serving and providing education to their customers, schools and universities introduced online learning haphazardly, without much notice, training or support, in response to the pressure of covid-19. The scale of this change was unprecedented and its pace astonishing (Hodge et al, 2020; The Chronicle of High Education, 2020). In many institutions, e-learning was imposed as the “unique” available solution, eliminating the need or the usefulness of discussion. According to QS (2020), 74% of institution shifted some or their courses online, 39% changed the deadlines for application/registration, 31% had to delay some course offerings and 32% had to reschedule course start dates.

According to UNESCO (2020), most governments had to close institutions to fight covid-19, affecting almost one billion students worldwide. Regarding China’s policy of suspending regular classes in favour of online teaching, Zhang et al. (2020) identifies five problems:

- i) Lack of an adequate infrastructure;
- ii) Online resources were not spread equally and available resources were not well-known or mastered;
- iii) Limited instructors’ skills and experience with IT hindered their capacity of effective teaching;
- iv) Students and teachers both needed to have the ability and lifestyle adequate to learn/teach from home;
- v) There was no clear guide about what was a good pedagogy and transmission modality.

It may still be too soon to fully comprehend the full impact that the decision to go online had on institutions’ finances, students’ academic performance, employees’ and teachers’ moral and stress given the pressure to develop, implement and support, mass virtualization of courses for IT personnel.

The underlying/implicit expectation about successful e-learning is that teaching, and delivery of instruction are well planned ahead of time, and it can take place if and only if, emergent initiatives are built on robust foundations (Hodges, 2020).

In this paper, the authors examine if, during the Covid-19 period, four (4) pillars which are reputed to sustain e-learning success in the traditional view were considered: (a) student e-readiness, (b) teacher e-readiness, (c) organization e-readiness and (d) system e-readiness. Most of the literature on e-learning explores one or a mix of these constructs. This research report is an investigation on how each of these four pillars of e-learning was challenged by the pandemic. We question the adequacy of the models to describe success, in these disruptive times, from the perspective of the main actors, the students. All together, they are representative of past work on e-learning, when it was still a voluntary choice for students, teachers, education IT developers, education managers and organizational decision-makers.

The rest of this paper is divided into 5 sections. The first recalls the main success models for information systems and their potential application to e-learning. The second reorganizes the previous knowledge in the light of the four pillars of a successful e-learning usage in normal contexts (i.e., student e-readiness, teacher e-readiness, system e-readiness and institution e-readiness). The third section presents an e-learning success model with special consideration for the covid on the normal flow of interactions between constructs. In the fourth section, a methodology to challenge this new integrative model is discussed before the Data analysis section. Finally, a discussion and conclusion is drawn after some discussion on the results.

2. Background

E-learning is often called “distance learning” (Holsapple & Lee-Post, 2006). Choudhury and Pattnaik (2020) conducted an impressive systematic review of 138 articles (out of an initial list of 976) from the most relevant journals. They found definitions for e-learning ranging from the transfer of know-how using technology to using technologies to dispense curriculum. Their purpose was to critically examine the advantages, and disadvantages, the challenges and critical success factors, and the theories and models used to examine e-learning. Their review provides a profound view on the evolution of these themes with the evolution of internet, from web 1.0 to web 4.0. They also identified the main stakeholders in e-learning. These are; learners, instructors, the learning institutions, content developers, technology providers, accreditation bodies, and even the learners’ employers (or future employers).

2.1 Quest for dependent variables to assess success

In her extensive literature review, Dorobat (2014) identified four main approaches used to assess the success construct in the context of e-learning: a) those based on the DeLone and McLean (D&M) model with its extensions (net benefits); 2) those based on the Technology Acceptance Model (TAM); 3) models focused on users’ satisfaction; and 4) models focused on quality and performance.

2.1.1 Approaches based on the Delone and McLean model

References to the 1992 Delone and McLean model (D&M) are still abundant nowadays. They are based on D&M model’s original specification or on some adaptation of it. It has been the prevailing model of system success, where characteristics of the system (system and information quality) affect use and user satisfaction. This then leads to an individual impact which, in turn, is expected to translate into beneficial organizational impacts (see Figure 1).

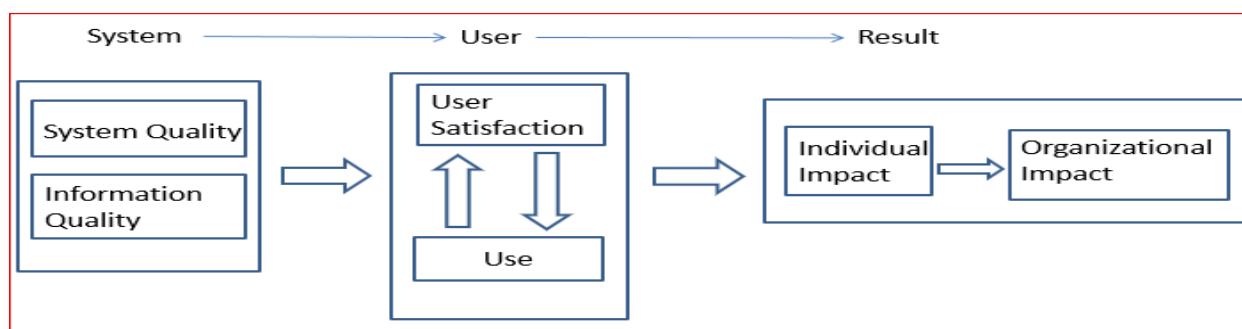


Figure 1: Delone & McLean (1992) I/S success Model

In their initial model, based on 180 articles, success is a positive organizational impact which is the resultant combination of the individual positive impacts of mutually reinforcing concepts; use and satisfaction. Use leads to satisfaction which, in turn, reinforces system usage. This pair of variables is determined by the combined quality of the system and the quality of information. This model may be better adapted to a time when many people feared using computers, and use was primarily in the context of producing information for organizational decision-making or transaction processing. Satisfactory computer use naturally leads to more efficiency from individuals which explains the subsequent positive organizational impact, seen here as the summation of many individual impacts.

Seddon (1997) presented a critical examination of the D&M model, arguing that the “use” construct was misconceived as a proxy for benefits from use. Instead, it is more adequate to consider it a behavior rather than a measure of success. As a behavior, “use” should be conceptualized as a consequence of expectations and beliefs. Given actual use, the author argues that system quality and information quality could result in perceived usefulness and user satisfaction (two perceptual measures of benefits) and that these benefits could be valuable in understanding how information systems’ impact individuals, organizations and even society.

A paper by Rai et al. (2002), aimed at assessing the validity of both models from data collected among 274 system users. Their study validated both models. However, the authors noted a problem with the notion of system use that they interpreted as being dependent on the system whereas user satisfaction is included as an “individual impact”. Seddon’s model incorporated the notion of system dependency which results from user satisfaction with the actual use of the system. Also, they changed the concept of system quality into the ease of use construct in both models, as a surrogate.

Despite its wide acceptance, criticisms to the original D&M model began to appear over time. Consequently, ten years later, the authors felt it necessary to update it (Delone & McLean, 2003). They proposed “enhancements” and “minor refinements” to the initial model, to consider a full decade of research that applied, attempted to validate, and challenged the initial model and proposed enhancements to it. Also, taking in consideration TAM (Technology Acceptance Model – Davis, 1989) research in which intention to use is modelled as a prerequisite to use, they also included that construct in their model, but kept the system quality construct instead of the “ease of use-friendliness” as suggested by Rai et al. (2002).

Following the lead of the end-user paradigm, specifically in the case of e-commerce, Delone and McLean incorporated a version of the ServQual construct (see Parasuraman et al., 1985). They kept an emphasis on “use” arguing that: “(while) most studies that follow D&M replace the Use box with Usefulness ..., we prefer to maintain Use as in the original work. (...) We (...) believe that use, especially informed and effective use, will continue to be an important indication of IS success for many systems” (p.17).

However, their new model did not include the perceptual measure of usefulness as suggested by Seddon (1997). The new model separates intention to use from use, which was an important decision according to Mardiana et al. (2015) as it allows links with TAM and other acceptance models.

Finally, to accommodate more different contexts, the authors merged individual and organizational impacts into a new construct, which they called net benefits. Their updated model does not prescribe a formal definition of net benefits. This was to allow for the context and the purpose of the system to help define how to measure its impacts. That construct is congruent with Seddon’s (1997) three points of view about measures of benefits: for the organization (costs of delivery, flexibility to time and space markets, etc.), for individuals (teachers and students) and for society. The resulting updated model, often named “Information System Success Model”, in short ISSM, is presented below:

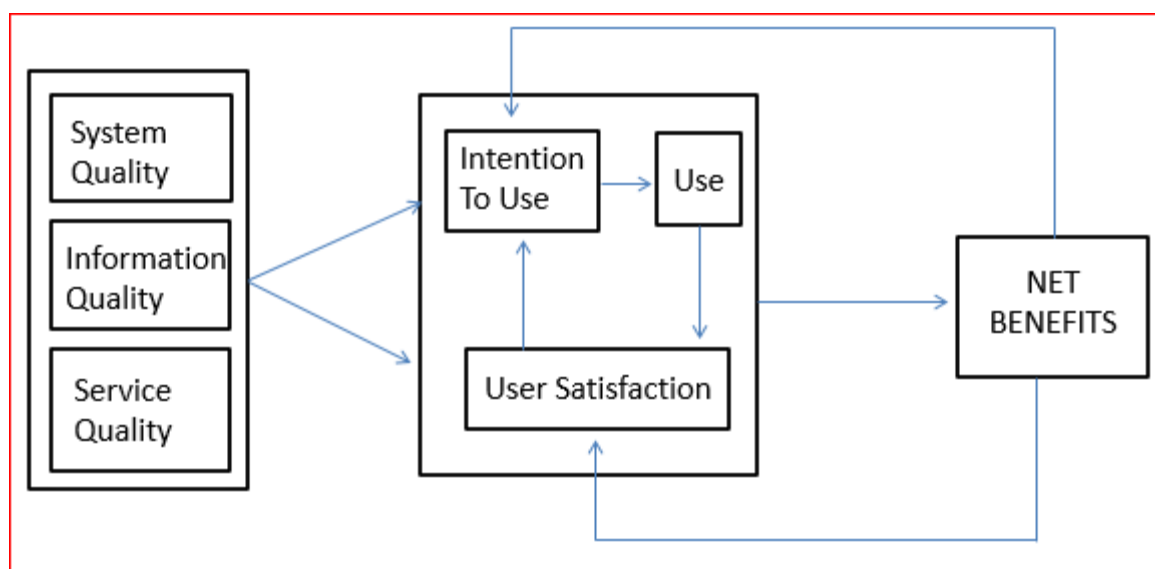


Figure 2: Delone & McLean (2003) updated model

2.1.2 Other models inspired from Delone & McLean

The ISSM has been adapted in many other contexts by researchers, namely to e-learning. Table 1 summarizes the most relevant:

Table 1: Main studies relying on the Delone & McLean models

Authors /context (year)	Independent variables	Intervening variables	Dependent(s)
Gunesequera (2020) - Meta-analysis of 37 studies on ISSM	<ul style="list-style-type: none"> ISSM variables Potentially Education quality, perceived usefulness & ease of use, self-efficacy, usability, efficiency, reliability 	<ul style="list-style-type: none"> All ISSM model 	Net benefits
Yakubu & Dasuki (2018)	Service quality, system quality, information quality	User satisfaction Behavioral intention	Actual usage
Seta et al. (2018)	<ul style="list-style-type: none"> Technical system quality Educational system quality Service quality Content and information quality 	<ul style="list-style-type: none"> Use User perceived satisfaction 	Individual impact
Ramirez-Correa et al. (2017)	ISSM model	ISSM variable	Net benefits, learning style is moderating
Chang et al. (2017)	<ul style="list-style-type: none"> Subjective norm, enjoy experience, computer anxiety, self-efficacy 	<ul style="list-style-type: none"> Perceived usefulness Perceived ease of use 	Behavioral intention to use
Mohammadi (2015)	<ul style="list-style-type: none"> Educational quality, service quality, technical system quality Content and information Perceive ease of use and usefulness 	<ul style="list-style-type: none"> Satisfaction Intention to use 	Actual use
Mardiana et al. (2015)	<ul style="list-style-type: none"> ISSM model TAM & Unified theory of acceptance and use of technology (UTAUT) model (see Venkatesh et al., 2003; 2016). 	Intention to use, use, satisfaction	Net benefits

Lee-Post (2009) - Research action and students survey	<ul style="list-style-type: none"> System (design & delivery, use) Student, instructor 	Student outcomes (benefits, satisfaction)	Institutional outcome
Larhib et al. (2006)	ISSM variables where e-learning content and pedagogy is used as a measure of information quality	ISSM variables: intention to use, use and consequent satisfaction	Faculty/Organizational benefits
Holsapple and Lee-Post (2006) - Several surveys with students	<ul style="list-style-type: none"> ISSM model 	ISSM model Perceived value of various aspects of the e-learning experience	ISSM model

2.1.3 TAM models

According to Sumak et al. (2011), 86% of research on e-learning acceptance is based on TAM, (based on a meta-analysis of 42 articles from major journals). Their model has the advantage of identifying antecedents to perceived usefulness and perceived ease of use but fails to identify them as independent or moderating variables. These “prior factors” are shown in their model and presented in Figure 3.

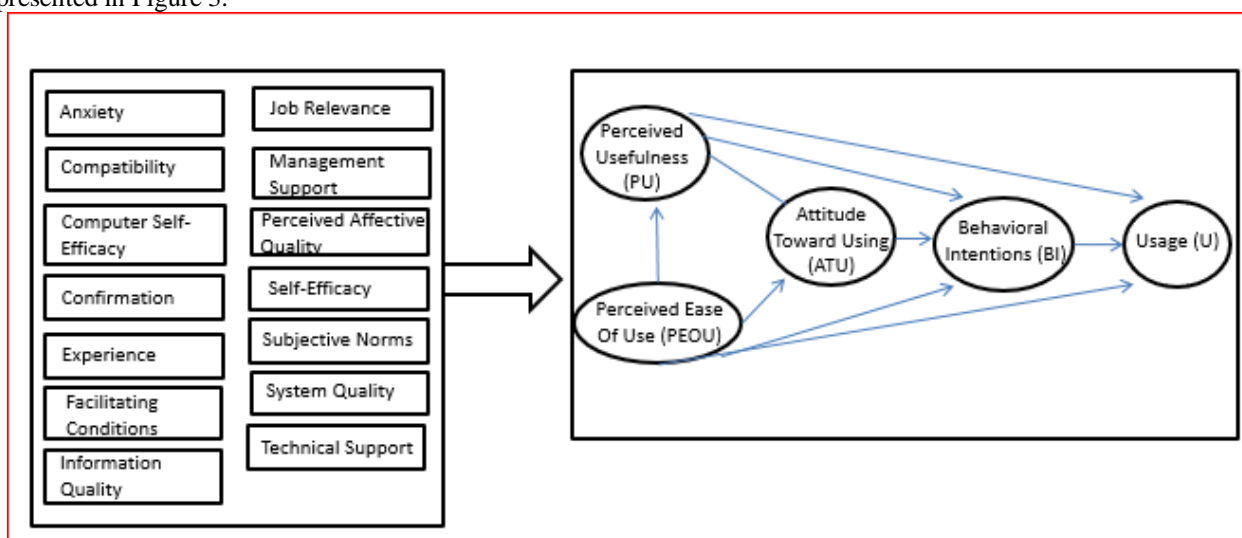


Figure 3: Sumak et al's (2011) meta-analysis of TAM use in e-learning studies

Overall, TAM-based models are widely used in Information System (IS) literature. TAM is based on Fishbein & Ajzen's (1973, 1985) model named Theory of Reasoned Action of consumer behavior (later followed by the Theory of Planned Behavior). Both recognize the evaluation of subjective and normative beliefs about an object under consideration, like an e-learning session. This evaluation results in an attitude which combines with perceived control to generate intention to use. As such, TAM highlights the importance of attitude and its effect on intention to use. Similarly, Mayer (2020) suggests that e-learning sessions are being processed at an affective level (formation of an attitude) before being processed by cognitive functions and that learning happens as the ultimate output of this chain.

Recognizing the need to introduce an affective dimension to explain intention to use, Davis et al. (1989) developed the Technology Acceptance Model, where the two main constructs, perceived usefulness and perceived ease-of-use are modelled as determinants to attitude and behavioral intention to use. This is necessary for acceptance and to ensure subsequent use (see Figure 4).

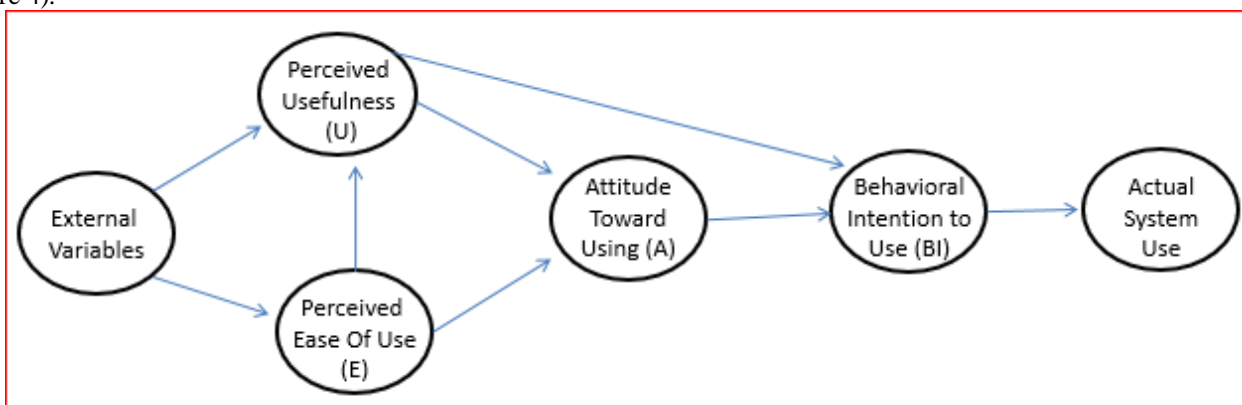


Figure 4 : Technology Acceptance Model (Davis et al., 1989).

This model was widely used but also challenged. It evolved into the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003; 2016). See Figure 5.

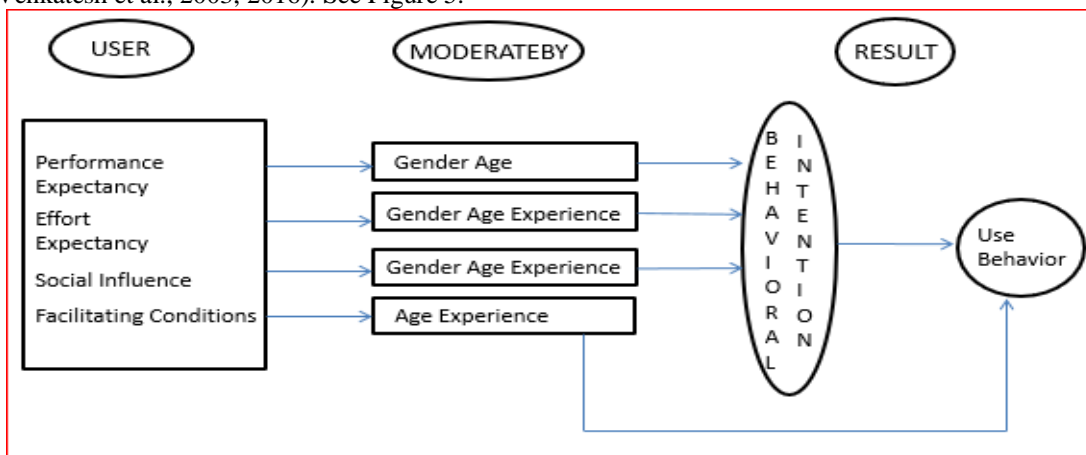


Figure 5: Unified model UTAUT by Venkatesh et al. (2003; 2016).

This model proposes that performance expectancy (former perceived usefulness) and effort expectancy (former ease of use) are not sufficient to explain usage of a system. Facilitating conditions (like systems characteristics) and social influence are also important in determining this behavior. UTAUT incorporates moderator variables, namely experience and voluntariness of use. Mayer’s (2020) study suggests that emotions play an important role in e-learning effectiveness. This includes positive emotions like enjoyment but also negative emotions such as anxiety and boredom. Empirical evidence of this potential effect of emotions is given by Abdullah et al. (2016) in which they find that enjoyment is correlated with perceived usefulness and perceived ease of use but computer anxiety is negatively correlated to perceived ease of use.

Beliefs also affect IS acceptance. *Self-efficacy* is defined as an individual’s belief in his/her capabilities in executing behaviors needed to bring about specific performance goals (Bandura, 1997). It impacts both perceived ease of use and usefulness (Mayer, 2020). Moreover, Punnose et al. (2012) found that among the main indicators of the intention to use e-learning were perceived usefulness, perceived ease of use and *subjective norms* (part of beliefs). See Figure 6.

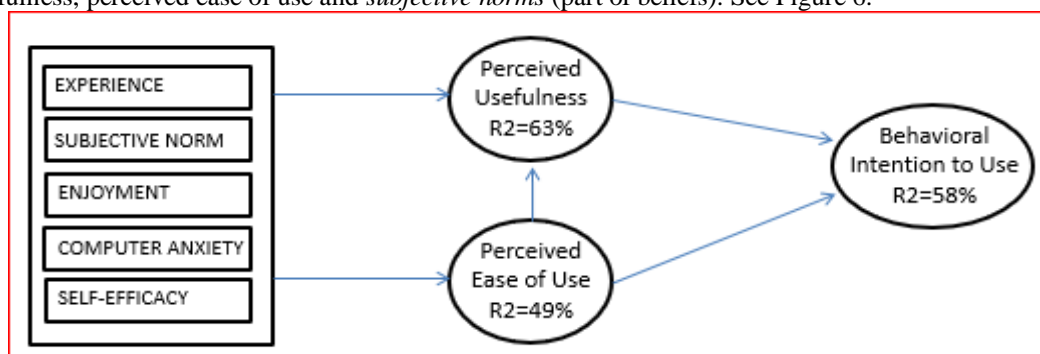


Figure 6 : Punnose et al. (2012) of behavioral intention to use

In these models, the concept of acceptance is a merger of system usage and the consequent satisfaction and/or performance expected. This may be somewhat reminiscent and vestigial of the previous century when many people experienced anxiety and fear when using technology. It was therefore believed that acceptance was important to ensure use which would lead to improvements in efficiency or effectiveness.

Both TAM and UAAUT, as well as similar intermediary models (Theory of Planned Behavior and Reasoned Action) focus on factors explicative of system usage given its potential user’s characteristics and normative beliefs. As in the case of Covid-19, volitional use of IT was not always possible. Many e-learning solutions were forced upon both teachers and students. This must be considered given that it is forced behavior. A study by Belletier et al. (2018) reports that TAM and TPB both predict intention but may fail to predict actual behavior, which would be more a consequence e-learning capacities and availability. Table 2 summarizes some important variables.

Table 2: Main variables

Authors (year) /context	Independent variables	Intervening variables	Dependent(s)
Cidral et al. (2018) - Survey 301 Brazilian students	<ul style="list-style-type: none"> • Collaboration quality • ISSM: Service quality, information quality, system quality 	<ul style="list-style-type: none"> • Use • User perceived satisfaction 	Individual impact (effectiveness, productivity, ease to perform task, usefulness for job)

	<ul style="list-style-type: none"> Instructor attitude, diversity in assessment, learner interactions 		
Abdullah et al. (2016) - Survey (242 UK students)	Experience, subjective norms, enjoyment, computer anxiety, self-efficacy	Perceived usefulness Perceived ease of use	Intention to use

2.1.4 Models based on users' satisfaction as measure of success

Among the surrogate measures of IT effectiveness, user satisfaction is very often used. A meta-analysis of 37 recent studies on e-learning satisfaction reports that 13 of these supported the ISSM information system success model (Gunsekera, 2020). It identified three usability attributes of e-learning: satisfaction, learnability, and efficiency. The study concluded that, among the satisfaction theories and models of satisfaction, ISSM was well-grounded.

A study by Gonzales-Gomez et al. (2012) with 1185 students reports that satisfaction can be greater in women. This group appeared more concerned with planning and having contact with the teacher.

Another model (Sun, 2008) correlated perceived e-learner satisfaction with six categories of antecedents: learner (attitude toward computers, anxiety, self-efficacy), instructor (attitude toward e-learning and responsiveness), course (flexibility and quality), technology and internet quality, design (perceived usefulness and perceived ease of use) and environmental dimension (which strangely include diversity in assessment with interaction with others).

Wu et al.'s model (2010) presents learning satisfaction as the ultimate measure of success. It is a consequence of meeting the learner's performance expectations and of the quality of the learning climate. Wu et al.'s learning satisfaction construct borrows from Chu (2005) which includes learner characteristics and incorporates an emotions component from Sun (2008). Overall, the model considers users' characteristics, system functionality, content characteristics and the quality of interactions.

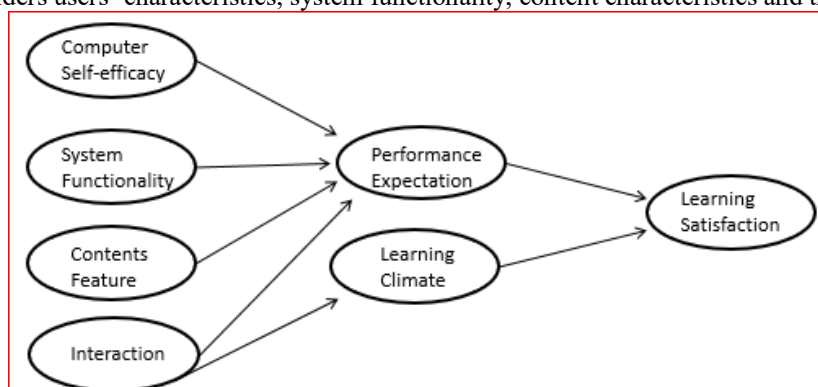


Figure 7: Wu et al. model (2010)

2.1.5 Models based on performance and other models

Two types of study are encountered: measuring effectiveness of e-learning blended learning or comparing effectiveness between e-learning, blended learning with traditional learning. Chou and Liu (2005), studied 210 students of Taiwan for 14 weeks and compared learning effectiveness (performance, self-efficacy, satisfaction and learning climate) of e-learning group with a control group. They found that the e-learning group outperformed on all four variables and concluded that learner control was the main explication for this success. If studies using satisfaction as a surrogate measure for success are numerous, conversely, there is a scarcity of studies using student performance which is yet a relatively easy to collect and directly related to the objective of teaching. Owston et al. (2013) present the results of a survey with 577 students engaged in blended learning in which they note a very strong relation between grades and their general satisfaction, the convenience, senses of engagement and views of learning outcomes. A study by Alholay et al (2018) use the ISSM main model variables, i.e. system quality, information quality and service quality that merge into an intervening variable Overall quality which affects in relation to self-efficacy both user satisfaction and actual use which impacts performance.

Such a model was proposed by Lee and Lee (2008) which introduces academic performance as the measure of e-learning success. Their model looks like an extension of ISSM but its orientation toward e-learning differentiate it enough to deserve a special consideration. The three first constructs are named in a similar manner or are inspired from ISSM but adjusted to the education process and context. Perceived usefulness and ease of use are not intervening variable but independent variables related to the system sustaining the delivery of the knowledge. They validated their model with 225 students, as Figure 8.

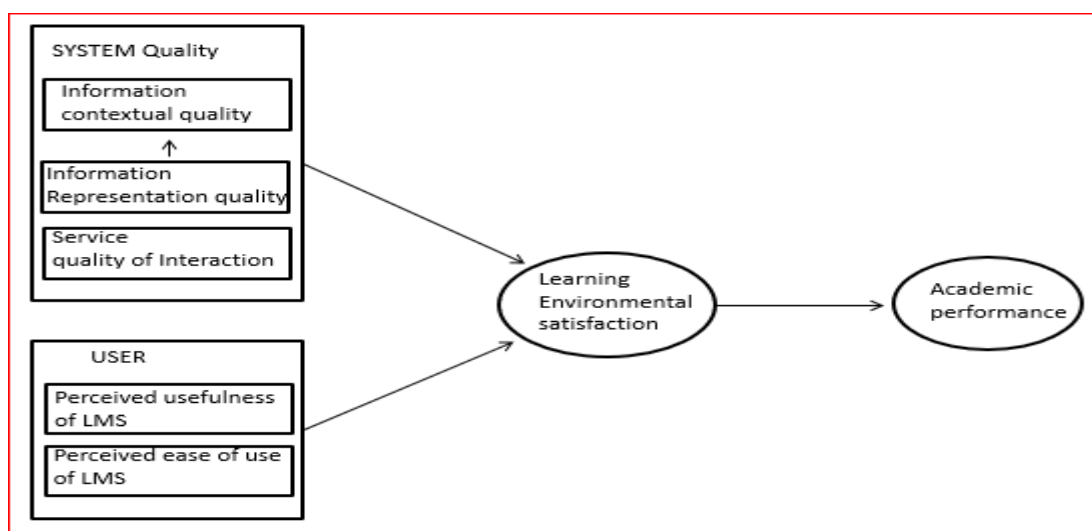


Figure 8: Academic performance as the dependent variable (Lee and Lee, 2018)

2.1.6 Holistics models and other measure of success

a) quality of e-learning

A recent study of factors affecting e-learning quality specially in the covid-19 crises as been conducted by Elumalai et al., (2020) which concluded that all hypothesis were supported. But his questionnaire suffers from flaws. First, the questionnaire was distributed in two countries and to different level (graduate and undergraduate). Second, quality was assessed by degree of agreement with six questionable statements (page 739) :

- “E-learning raises the level of students’ attainment and makes it enjoyable”; one concept per question.
- “E-learning improves the instructor’s presentation of contents and activities”; this question using “improves”.
- “E-learning enhances the bonding between instructors and learners”.
- “E-learning is more user friendly and convenient for instructor and learner” (double construct)s.
- “E-learning enables the instructor to record the lecture and listened again by learners” (double questions one factual and the other potential)
- “E-learning provides two-way communication and cooperation among students” (two concepts)

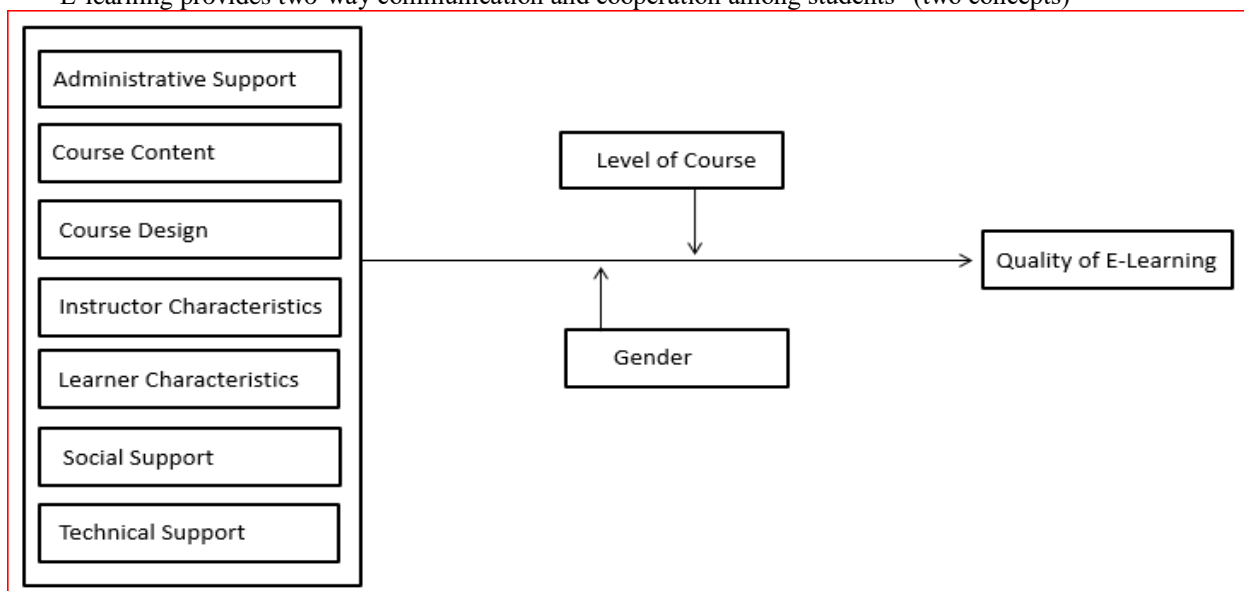


Figure 9: Elumalai model for quality of e-learning

b) effectiveness of educational process

Lately Tatavulea et al. (2020) examined the effectiveness of online education with 362 respondents (student and teachers) from 13 European countries and found that online was less effective than face-to-face education; their study suggest that student-teacher communication, immediate feed-back, institutional support, trust in the system, effectiveness of instructional and assessment methods were critical. They found that the factors most linked to effectiveness are institutional support, effectiveness of assessment methods and trust in the system.

An important aspect of education is learner retention, according to Lee et al.(2018), who conducted a survey with 204 students. Her model verified that two rigid contents (system quality and content quality) and two flexible contents (test quality and

activity quality) determine learner satisfaction which is very strongly to learner retention. Her data did not support her hypothesis that instructor involvement would moderate the relation to satisfaction.

c) learning outcomes

An adaptation of Kirkpatrick (1959) model to Higher Education by Praslova (2010) suggests the following measures for the four stages:

- i) Reaction: Asking learners their affective reactions and the perceived value of the instruction
- ii) Learning: should be measured directly by tests, grades, objective performance to verify if student learn anything and if there is a difference in skills and knowledge
- iii) Behaviour: Observation and surveys can be used to verify if student can actually use the knowledge and skills acquired during training, if it is remembered and apply to work
- iv) Results: more long term measure by observation or control group on the worth of the training as improvement in student life such as career progression,

d) mix model of success

ISSM model has been criticized for its focus on use as a surrogate for success. According to Freeze et al (2010) who performed a study on 674 students, system success would be more impacted by user satisfaction than by system use, which is more or less voluntary. In their model system quality and information quality have both an effect on usage and satisfaction but they did not take into account service quality in the context of e-learning.

Indeed abandon rate has been often mentioned as a weakness of e-learning (Ilham et al, 2020; Alem, 2013). An other approach to e-learning success model is given by Joo et al (2011), who propose persistence and satisfaction as dependent variables. For them, Persistence is judged as important as satisfaction, although influenced by satisfaction. Their work was based on Garrison et al (2004) study which determined that satisfaction was dependent mostly on social presence, and on teaching presence for the face-to-face teaching while, for the experienced e-learner, the cognitive presence is far most the important factor in satisfaction. A model of factors acting on continuance intention based on satisfaction is proposed by Joo et al (2018) where satisfaction is function of perceived ease of use and usefulness.

Lee et al. (2011) propose a model where success is measured by satisfaction and academic results and satisfaction are witness of success being driven by the quality of three types of support: instructional, peer and technical. If all three type of support are correlated to satisfaction and satisfaction is weakly related to academic performance, his study with 110 students did not find a direct relationship between academic performance and any of the support.

One sect peripheral of success is presented by Luo et al (2017), who questioned 643 students to assess the sense of the community which favor the stickiness of student to the e-learning environment. They report that sense of community is determined by the relations student-instructor and student-student both moderated by the student-control and access to learning content. Another approach to performance impact is given by Aldolay et al (2018) who propose a model where ISSM system quality, information quality and services quality sum up as an intervening variable, overall quality. This quality and self-efficacy determine user satisfaction and actual use which lead to performance impact.

e) Models with individual impacts

In an effort of synthesis, Cidral et al. (2018) propose the individual impact as a measure of e-learning success, subsequently to use of the system and perceived satisfaction. These two construct are correlated to the DeLone & McLean (2003) model constructs: system quality, information quality, service quality, to which he adds: collaboration quality, and the following variables from Sun (2008) model: learner computer anxiety, instructor attitude toward e-learning, diversity of assessments and perceived interaction with others.

2.2 The e-readiness constructs

Lee-Post (2009) presents a model where more stakeholders are included and the nature of benefits are split between students and institution. Using e-learning context, as suggested by the upgraded model of ISSM Larhib (2006) adapt it as shown in Figure 2 below, replacing “net benefits by “learner satisfaction” and benefits by “teachers/organizational benefits. In this adaptation of the traditional model for ISSM and the Lee’s model, the main constructs are detailed below:

- A) System readiness: It refers to the adequacy of three constructs (DeLone & McLean, 2003; Rai et al., 2002):
 - System quality: it refers to the use of IT for course material delivery and underlying technological capacities and constraints: Criteria for quality refer to ease of use (namely navigation and friendliness), degree of graphical realism and multimedia capacity, stability, links with other systems (ex: author systems, simulations, etc), and reporting system sophistication
 - Information Quality and pedagogy quality: it refers to content (interesting and informative), interaction dynamics (group work and communication), learning resources (interactive, engaging and responsive), possibility to incorporate a large spectrum from real-word input, simulation, interactive animation and Virtual Reality, organization, adequate length, clarity, usefulness, relevance and actuality, speed of access and response time, security, availability

- Logistic quality of the service: this is the systemic proprieties resulting from the combined behavior of all technical tangible and intangible components. Delone& McLean (2003) define it as by up-to-date hardware and software", reliability, responsiveness, knowledged (assurance) and IT staff empathy toward users. In e-learning context, it comprises access to educational resources referred as anytime/anywhere learning, availability of on-line tutor or mentor, student support service providing access to resources (library, fee payment, registration, etc)

B) Teacher e-readiness:

Teachers are main actors of learning and their role in e-learning is important to offer significant teaching experiences to the students, but despite they need to face the challenges of changing abrupt change in their work, they are not prepared Zimmerman (2020).

Distance learning has altered their roles and responsibilities from course master and givers to course developers and animators, mastering many technologies. Teaching become a more formal experience, since the presenter becomes a coach, the presence of students being less tangible, more time spent working with a discussion board and e-mailing. Emphasis is on feedback, the bulk of the work consisting in corresponding with students. The professional status, job security, workload, rewards, and intellectual freedom are being diminished as well. Among the new skills expected from teachers, Bernard et al. (2017) mention:

- Engagement strategies — to engage the learner in the content and the process of the on-line class
- Content delivery — skills for preparing and delivering content
- Remediation skills — trainer must know and respond to learners when they are confused
- Facilitation — skills to make the learning process easier for the learner
- Assessment — building assessment processes into learning without de-motivating the learner
- Accountability — strategies for providing accountability for the learner and for making learners accountable to instructor/course requirements
- Contracting for learning — articulating the roles and expectations of the on-line learning process
- Live versus on-demand — deciding when to use synchronous or asynchronous modes

A study in Saudi Arabia responded by 96 faculty based on an extensive literature review on assessment in virtual learning environments reports that neither the institutions neither the faculty were adequately prepared to conduct assessment of the online teaching as stated by Sharadgah, (2020) which also reports that Faculty complaint on the lack of training to develop e-assessments, and mechanisms to guarantee privacy and prevent cheating.

A study by Ng et al. (2020) finds that that teacher must have a leading role in building a fruit full combination of synchronous and asynchronous approaches to favor student interactions. Tartavulea et al 2020 found that teachers were not ready to face the change but their survey in Europe indicates that the transition from in person to online was relatively successful in terms of support received, oneline platforms, transformability of courses, adaptability of students. But this forced teachers to spend much more time to prepare for class. In regards of the preparation of teachers Borup & Evmenova (2019) reports that training of teachers is best achieved when teacher can apply the e-learning style they received to the design of their own teaching.

C) Organizational Readiness:

Many Higher Education institutes were not ready to face covid and massive switch to e-learning was the only approach that seemed feasible in order to save the term and pursue their mission until the end of he pandemic (Shardgah et al, 2020). This lack of preparation meant that they launched e-learning without offering proper guidance namely about assessment modes, and consequently the treatment of cheating, the privacy and confidentiality of communications etc. This construct measures the capacity of an organization to offer e-learning services, in terms of its infrastructure capacity, its management, and financial technical and technological capacity.

It covers a wide range of factors

- Financial readiness (budget size, allocation process, monetary and workload compensation for developing courses)
- Technological skill readiness (competencies and presence of e-learning experts from pedagogy to technology)
- Equipment readiness (appropriate quantity and power, namely internet bandwidth), namely the capacity of servers to support online assessments (Sharadgah, 2020);

D) Learner readiness

Many study include a variable of Self-capacity that is part of e-readiness (Abdhulla, 2016; Punnose, 2012; Wu et al, 2010; Lee & Less, 2008; Sun et al. , 2008). Following a systematic review of literature, Alem (2013, 2014, 2016) developed an instrument which was validated and yielded with high predictive validity. In this research it has been preferred since it encompasses all dimensions of readiness and has been validated. It includes the following five aspects:

- Motivation (goals and purposes) style life and focus capacity.
- Self-directed learning capacity (study habits and learning preferences).
- Technical competence, mastering technology.
- Perceive usefulness of e-learning.
- Financial capacity to access to needed devices.

2.3 The COVID impact on the model

The main model inspired from Delone & McLean (2003) and the models using more or less the theory of planned behavior give to USE the special status of either an objective or a necessary intervening variable for user satisfaction. They take as granted that voluntariness is possible and the need to increase or improve use make senses. But the UTAUT (Venkatesh et al., 2003) mentions that voluntariness is a moderator of the intention to use. The covid-19 changes this voluntariness aspects and shortcuts the intention to use leading to use.

2.4 Research proposal for an integrated model

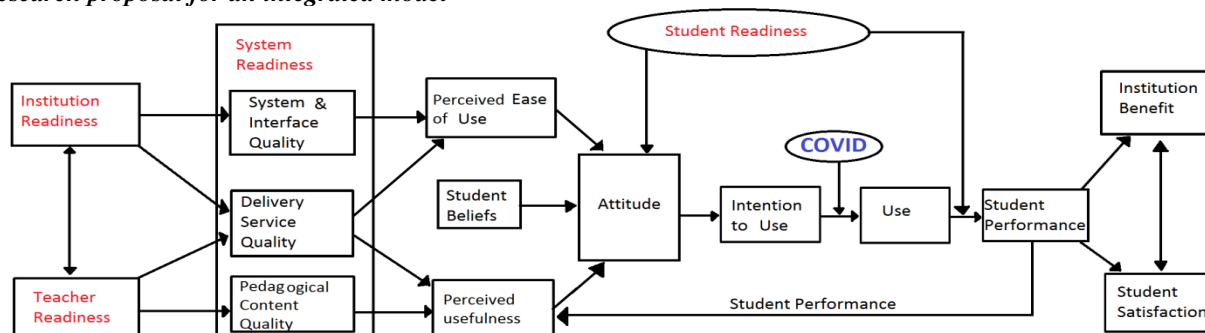


Figure 10: this research proposed model for the covid role

3. Research Design

In order to verify empirically the impact of covid on the model of success, a questionnaire was elaborated and to be distributed to an adequate sample. It is composed of the right part of the research model: from the antecedents of Attitudes to student satisfaction, as seen below:

Table 3: Source of scale for measurement

variable	Scale source
beliefs(7)	Punnose (2012), Sun et al (2008)
Perceived usefulness (6)	Punnose (2012)
Perceived ease of use (6)	Punnose (2012)
Behavioral intention if no covid	Punnose (2012)
Attitudes to ward e-learning	Venkatesh (2003)
Performance	Alem (2013; Larhib, 2006)
Satisfaction with system	Lee et al, 2008;Seta, 2018; Cidral, 2018, Owston, 2018)
Satisfaction with e-learning	Alem (2013)
Satisfaction with process	Elumalai (2020)
use	Number of hour using the system weekly
Student e-readiness	Alem (2013)

4. Conclusion

Some universities in the UK have already begun implementing different approaches. Namely, Queen’s University Belfast has arranged direct charters from China to accommodate students willing to come back for their study. In Western England, 20 000 are expected (Mingjie & Yingzi, 2020). According namely to Zimmerman (2020), if student learned as much during this experimental (for all stakeholders) year of covid, then faculty role, as we know it now, may well be changed forever, and jobs may be lost. This is why an empirical investigation of the role of covid on assessment models is needed.

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I-Fintech adoption readiness

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ABSTRACT

Various studies show information technology can beneficially apply to enhance financial services. The merger of Fintech, based on the Islamic law, creates the concept of Islamic Fintech (I-Fintech). The growing investment and numerous startups across Islamic Fintech offer financial innovation evidence of the importance of I-Fintech. Many governments support I-Fintech growth through investments and supporting startups. Pakistan, an Islamic country, is experiencing evolutionary changes in Fintech adoption. This I-Fintech adoption can engage governments, companies and firms across the Islamic world. Eighty five percent (85%) of Pakistan's population lack financial services. Hence, financial inclusion is a dominant problem of Pakistan. To date, few I-Fintech companies or firms operate in Pakistan. These are limited to big cities like Islamabad, Karachi and Lahore. To date lack of investment has restricted I-Fintech growth processes. Thus, a demand for local corporate and firm engagement is desirable to capture full advantages across the Fintech sector. This paper proposes a conceptual framework for adoption of I-Fintech across Pakistan. It proposes Islamic Fintech challenges and risk affect intention to adopt I-Fintech in Pakistan. Intention to adopt I-Fintech technology contains the constructs of technical literacy, financial literacy, digital literacy and social acceptance. This study's next stage is to measure and model competitiveness position of Pakistan's Islamic financial institutions (by gauging their resultant collective intelligences position).

Keywords: Fintech, I-Fintech, Banking, Islamic Countries, Shariah, Finance, Blockchain.

INTRODUCTION

Background

Information Technology has helped in bringing innovative ideas in businesses and the daily life of common man. Information Technology has provided many of the solutions to various businesses pertaining to the financial and infrastructure sectors. The financial solutions provided by the technology is called FinTech or Financial Technology; it is obvious the two words have been shortened to Fintech (Echchabi et al., 2021). Various benefits have been provided by Fintech such as fairness in business dealing, lower cost in transactions, ease in finding or communicating with customers and the direct and easy availability of various types of information, including financial information (Zavolokina et al., 2016). Business volume has been increasing by transformation of business transactions to smart devices including online remittances, payment of bills, equity and insurance and so on. Moreover, the interest likeliness has been observed by commercial banks of Fintech-based financial solutions.

Islamic Fintech (I-Fintech)

As the name implies, Islamic Fintech are the financial services purely based on Islamic Shariah law and for this purpose various Islamic banks and traditional banks are offering their services to their customers for various benefits. Most Islamic governments support Islamic Fintech including the Dubai International Financial Center (DIFC) which reserved a Hundred million dollars fund for Fintech and the sandbox of the Bahrain regulator. There are some other private alliances for Fintech growth such as Turkey's Al Barakah Bank's accelerator arm with Singapore for uplifting and supporting Islamic Fintech or I-Fintech (Tarique & Ahmed, 2019).

Global Landscape of Islamic Fintech (I-Fintech)

Startups in Fintech have presented evidence of a global landscape in the latest IFN report of 2020 (IFN,2020). The growing marketability and development are evident inside the Islamic Digital Economy as shown in Figure 1. Islamic Fintech's role is being explored by academia and industry, while according to Oseni & Nazim (2019) academia is progressing slower than industry as new studies prove. According to the IFN (2018) report, Fintech companies need to follow three types of requirements to be considered as recognized Islamic Fintech companies. The first one is the availability of internet or mobile app-based financial services. Another requirement is the financial services must be based on Islamic shariah compliance. The third and last one is that the company must have finalized a business, or the company is performing the minimum viable product (MVP) process development.

Islamic fintech start-ups by country of establishment

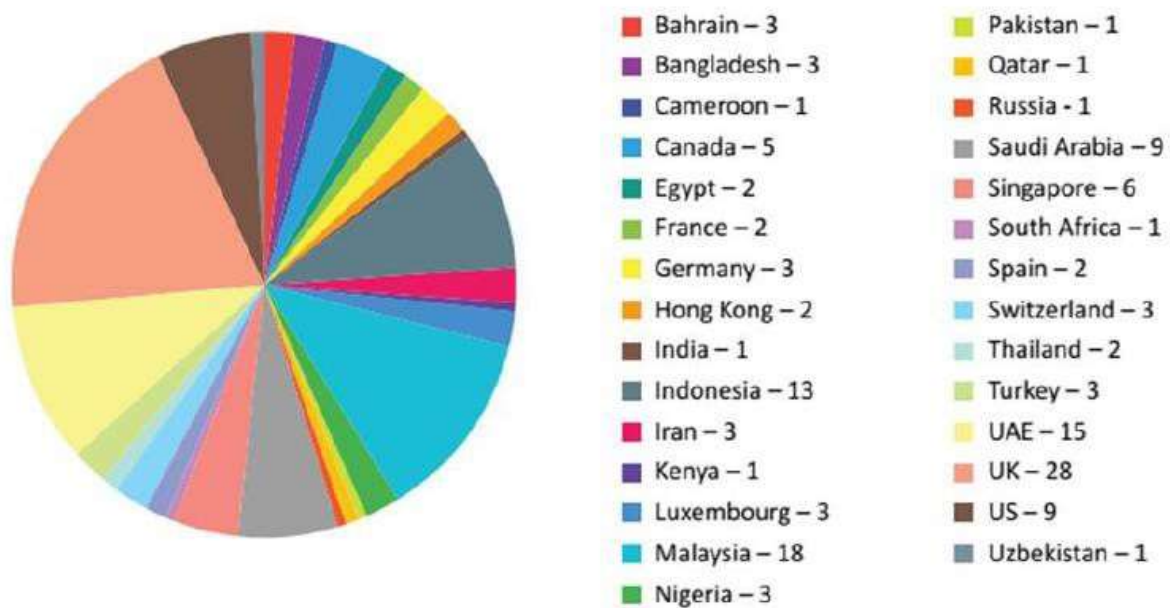


Figure 1: Countrywise Fintech Startups Source: (IFN, 2020, p.17)

Fintech in Pakistan

Fintech in Pakistan is a new sustaining technology, and is growing gradually. Debit cards, credit cards and ATM machines are the basic and popular products of commercial banking. These products were added to the basic services because of the change of financial systems towards technology. According to Rizvi et al. (2018), a revolutionary change of technology has been seen in Pakistan resulting in intelligent financial solutions. The main financial services and financial products have been using improved technology, which has increased the productivity of the financial system. Pakistani Fintech can be categorized in two groups, namely traditional and emergent Fintech. The traditional system works with the incumbent whereas the emergent is working with banks and firms. As the name implies, traditional Fintech in Pakistan deals with traditional price models and products and emergent Fintech is innovating some new technology driven solutions

Motivation and Gaps to be addressed

Islamic finance should apply Artificial Intelligence (AI) and big data analytics in more areas of business as business may gain more benefits from AI. Distributed ledger technology could boost Islamic trade financing and reduce the incidence of Shari'a non-compliance. Wealth management can be simplified using AI. Takaful needs traction and innovation to capture the Muslim insurance market.

Many empirical and theoretical studies are available on financial inclusion in Pakistan, but these studies do not discuss the topic directly; rather, they discuss other subtopics which may be somehow relevant to financial inclusion, including poverty elimination, economic stability and reduction of income disparities based on economic development (Shahbaz and Islam 2011; Nenova et al., 2009; Akhtar and Hussain, 2015;).

LITERATURE REVIEW

I-Fintech Challenges

The list of challenges in I-Fintech is lengthy and long. These challenges typically range across legal or regulatory (Saksonova and Kuzmina-Merlino, 2017), market or business, educational or behavioral and technical domains (Rizvi et al., 2018). Modern regulations, including legal, innovation (business), scalability (technical) and testing of a network, plus behavioral considerations (Elasrag, 2019), remain important challenges in I-Fintech (Murinde et al., 2022) when using blockchain technology (Mohamed and Ali, 2018; Salah et al., 2019). The tradeoff understanding between the blockchain and the database remains a key skill that still needs further improvement (Cole et al., 2019). First, the weaknesses and strengths of each approach must be understood. Balancing the positive power of blockchain and its combination with the benefits of databases and their applications still requires mastery (Guo and Yu, 2022; Khalil & Gervais, 2017). Research continues exploring and discovering the balance and re-balance between technologies and databases (Khalil & Gervais, 2017). Some of the challenges for the implementation of Fintech using blockchain are presented below.

Economic Benefits

The economic benefits can be understood in cases where technology and high tech activities provide economic benefits along with user friendliness (Walker and Johnson, 2006). The older methods and traditional approaches are being slowly replaced by new and advanced activities and services based on technology. The goal is the various benefits provided to businesses and to

help businesses attract a greater number of users, especially when available to users in terms of security and certainty while performing financial transactions (Nambiar and Lu, 2005). The various uncertainties such as related to environment would be reduced while using technology such as in the perspective of I-Fintech, and the building of customer trust can be achieved. For building of customer trust in businesses or service providers it is very necessary to present a higher degree of Fintech services with all available and desirable benefits (including economic benefits) for the users. To grow customers, a higher level of Fintech services includes strong privacy policy, best quality service, supplier reputation, security and integrity control so that customer and service provider relations can be maintained for the long term (Siau and Shen, 2003). Secure transactions and funds shifting with ease and other benefits such as relaxation can build a higher level of trust and provide a galvanizing impact of Financial Technology (Kim et al., 2009).

Convenience

Convenience may be considered as 'ease' or perception of the product or service within some 'range of ease.' (Convenience, 2022). The sum total of efforts and time spent by an individual to purchase a product or to avail of a service is called convenience (Copeland, 1923). In the same context, time and effort used to avail oneself of banking services using a mobile banking platform can be called convenience (Lee, 2015). So, I-Fintech must provide ease in availing of its services and must save time. A catalyst in extending and growing financial services - such as mobile services and electronic services - is their convenience, plus other catalysts such as safety, affordability and accessibility. Various research studies have elaborated the concept of convenience in perspective of typical retail channels (Bergadaa and Del Bucchia, 2009; Gahinet and Cliquet, 2018; Seiders et al., 2000; Labb'e-Pinlon et al., 2016). Therefore, there is requirement to bridge the gap between way of shopping online. Studies for the design of convenience measurement pertaining to financial services are limited and the very few studies are available (Mevel et al., 2021; Gielsens et al., 2020; Vyt et al., 2017) especially in the perspective of a convenience as a role of digital variable and the affect of consumer response.

Smooth Tech Transactions

Fintech service providers ensure customer transactions are secure and information protection is provided. Further, Fintech services should be matching in accordance with the customer's lifestyle and the user friendliness must be provided (Mallat, 2007). In the similar manner, convenience is considered one of the perceived benefits of Fintech in which user is performing one touch payments or the transactions with minimum efforts (Nambiar and Lu, 2005). The previous studies have proved that perceived benefit of online application usage has increased the user intention of the adoption of applications especially in the various Information Technology based applications (Lee, 2009; Lee et al., 2013a; Lee et al., 2013b; Benlian and Hess, 2011; Farivar and Yuan, 2014; Abramova and Bo'hme, 2016; Ryu, 2018). Hence, in I-Fintech banking situations smooth, simple, one-touch transactions remain important considerations when pursuing customer acceptance..

I-Fintech Risks

I-Fintech is a booming industry and proves a disrupting technology for the financial sector and the proof is the global investment of billions of dollars. I-Fintech has the advantages for Muslim populations additional to the other benefits to non-Muslim populations, but the combination of risks are also available for these businesses that don't fit typical financial institutions. More than 2.7 billion Euros were invested in European Fintech in the first quarter of 2018 and a total of 12.4 billion Euros over the whole of 2018. Further, the United Kingdom has more than 2000 Fintech Firms and this number is expected to double by 2030. Business and investment growth is not without a combination of risks.

When the users of I-Fintech services perceive the uncertainty, or the negative results or consequences is called as risk. Much of the literature has been emphasized and achieved a positive attention by the uncertainty and the negative reinforcements especially in perspective of consumer innovation research (Mitchell, 1999; Lim, 2003; Ryu, 2018). The prior knowledge of technology should be provided to the customers or the early adopters to reduce the risks and uncertainties (Eiser et al., 2002). The user behavior has a significant role as well as higher level of influence by the digital literacy and literacy of technology while using technological products and services. In this regard, the I-Fintech service providers and the marketers must be able to understand the uncertainties, risks and other negative reinforcements before the implementation or deployment of the services of I-Fintech (Laroche et al., 2003). The study of Paylou (2003) presented that users have been found discouraging while performing e-commerce activities during the adoption of e-commerce services because of risks associated with the e-commerce. The risk has the influence over the demand of e-commerce and the Fintech service because the risk nature of bother services is same. In perspective of financial issues and the security, risk can be understood one of the most critical impacting factors during the process of Fintech adoption (Bensaou and Venkatraman, 1996; Slade et al., 2013).

Financial Risk

The probability of the losses (financial) experienced by the customer during the process of fintech usage or the transaction performance that would not have been experienced if the same transaction or activity have been performed rendering a conventional (alternative) method. The operation failure is considered the typical example of consumer-perceived risk which reduces the pace of Fintech adoption. The perceived risk framework has classified the risk within the panorama of financial, safety (psychological and physical), performance timeframe, convenience, social as well as the opportunity (Conchar et al., 2004; Torugsa and Arundel, 2017). The studies drawn from the risk processing framework four types of the risks have been identified within the context of the I-Fintech namely operational risk, financial risk, security risk and legal risk.

Legal Risk

Legal risks are considered when technology faces reduction in the adoption because of regulation and the administrative rules (Ryu, 2018). According to Razzaque et al., (2020) the Central Bank of Bahrain is serving as the controlling (regulating) body in Bahrain. Similarly, Bank Negara Malaysia serves the purpose in Malaysia (Muhamed et al., 2014). In respect to Pakistan, The State Bank of Pakistan (SBP) is the policy regulatory body and is the controlling authority for the banking system in Pakistan. A regulating sandbox in perspective of Fintech is called a mechanism or approach which keeps fast pace of the innovations or support information technology by developing the supportive regulations. The sandbox contains business models test platforms especially the I-fintech and Fintech companies otherwise the companies will try to continue operations outside the regulatory bodies umbrella (Todorof, 2018).

Security Risk

Another challenge is information security, which can be observed from the security attacks of recent years, questioning the current protocols and security standards. The Global State of Information Security Survey of 2016 reported that the year 2015 had a 38% rise in detected security incidents detected compared with 2014. The risk of fraud is another challenge resulting from digital banking and involves falsification of legitimate information and the manipulation and misinterpretation of electronic funds and digital information in databases. Global technology specialists have revealed that Malaysian digital transactions continued to grow by 54% even in the presence of various frauds and other challenges. There has also been a growth of 51% in stolen ID's. 58% of identity verification and 50% of cyber fraud prevention challenges have been identified as key challenges in the process of digital transaction growth as per the report of GBG, a data intelligence, identity verification and the fraud specialist (Abiola, 2015).

Operational Risk

Operational risk is considered one of the important and impacting financial transactions which is impacting negatively during the process of Fintech tools adoption. These tools are used during the execution of financial transactions in the context of operational risk in Fintech is more than the conventional tools used in conventional transactions. Bank of International Settlements (BIS) has described operational risk as the loss probability because of internal failure process or inadequate process, systems, people or the external events. The Fintech poses greater operational risk as compared to conventional tools of finance in context of failed or improper execution, process, delivery or any other activity. These situations will trigger a typical customer in an operational risk of high level for the usage of Fintech. The current study investigates the significant effects of operational risk perceived by the consumers to use and continue the Fintech usage.

Other Challenges and Capacities

Fintech has proved its importance from its introduction as the financial sector gained an impressive boost while introducing the amalgam of financial services and financial technology. A Fintech firm imposes various (additional/other) challenges to conventional institutions in terms of new innovative and novel or extended varieties of consumer products.

I-Fintech technology can greatly benefit if blockchain and other aspects of Fintech are implemented for the various offerings of products. The combination of Fintech and Islamic finance will require more efforts on monitoring so that the complex and difficult relationship of the key stakeholders and agents can be maintained. The trust issue may arise if increased monitoring is not available, especially when using new technologies. Financial solutions providers (Fintech Providers) are facing enhanced scrutiny imposed by governmental regulatory bodies. Efficient and common Fintech solutions need time along with the support of regulators for the Islamic financial industry.

The other challenge to the combination of Fintech and Islamic finance is the stakeholder's understanding, which is surely related directly to Fintech's abstract nature. The capabilities understanding and market progress of Fintech are due to the underdevelopment of Fintech's infrastructure and ecosystem. There are many security and privacy issues in Fintech solutions (Hassan et al., 2020).

I-Fintech Adoption

The use of products and services of Islamic Fintech can be understood as I-Fintech adoption (Oseni et al., 2019). The adaptability of I-Fintech requires policies, legislation and consumer protection laws so that the I-Fintech products and services will be of service to individuals and businesses as well (Ahmed et al., 2020).

Technical Literacy

The capability to use, analyze, and comprehend technology with responsibility, effectiveness and safety is called technology literacy or sometimes it is called technical literacy. Technical literacy can be defined as the use of technology for the creation, evaluation and integration of information. The technical literacy is not bounded to the internet and the use of computers, rather technological device, services such as Fintech or Islamic Fintech can be thought of technical literacy. As per definition of technology any system, tool, device or an approach or methodology designed to solve a particular problem or in other words to complete or carry out a task is called technology. Various activities such as using smartphone, tablets and laptops accessing through internet can discover, evaluate, review, and use data and information via different platforms can be calculated under the umbrella of the Technological digital literacy. The definitions regarding the technology change and evolve with the passage of time. An example of this approach is the digital literacy referred as the material of technology digital literacy. In this context

technology digital literacy is considered the sub-group or a specific form for the literacy of technology (Entrena and Ordóñez, 2013).

Digital Literacy

According to British Futurelab's handbook on Digital Literacy across the curriculum (Hague and Payton, 2010, p. 2); the digital literacy is explained as

Access of the broad-spectrum range of cultural and practical resources applicable to digital tools is called digital literacy. Digital literacy is the making and sharing ability of various formats and modes for the creation, collaboration and communicating effectively. It is the understanding of various digital technologies in which when and where these technologies fit best so that the processes can be supported.

In another definition stated by the European Information (Martin, 2005, p. 135) system about Digital literacy in a similar context has been Defined as

The attitude, ability and awareness of the persons to use digital tools and technologies and facilitation of the identification, managing accessing, evaluating, analyzing and synthesizing digital resource for the construction of new knowledge, creation of expression, creation of media and communications with others with respect to various life situations so that the constructive social action and reflection of this process.

Communicate effectively with others and the ability to create meaning are the two factors which have been emphasized the definitions. The later definition asserts the ability to search, assess and synthesize various digital tools.

Financial Literacy

The topic of financial literacy was under consideration by various research studies (Glaser and Weber, 2007; Hung et al., 2009). Financial literacy directly influences the person in context of the behavior. The combination of skill, knowledge, behavior, awareness and attitude is the formation of financial literacy is necessary for the effective and strong financial decisions resulting the financial wellbeing of the individuals. Every person possesses the varying level of financial literacy which impacts the behavior. The financial literacy needs attention because limited studies are available especially focusing concepts of Islamic finance.

The current study focuses and examines the attitudes and financial literacy in perspective of the Islamic finance. The study will analyze the degree of financial literacy of an individual such as awareness, understanding skills, set of knowledge understanding fundamental rules and mechanisms of Islamic financial information and services which in turn will enhance the ability to decision making of appropriate and effective financial decisions. The financial literacy is considered important because the financial knowledge is strongly adhered to the financial behavior (Xio et al., 2014). If a person is sound in financial literacy then he/she can avoid wrong financial decisions and make decisions (Lusardi, 2008) about high cost mortgages or the excessive amount of borrowing. The Islamic financial literacy will definitely affect the overall behavior of an individual especially while choosing between the Islamic financing and the traditional banking. It is also assumed that the Islamic financial literacy will enable a person to make financial decisions between conventional and Islamic financing.

Social Acceptance

The passive and active notions of the technology acceptance are considered in social acceptance such as (employment resisting) is a passive notion whereas the active notion when technology adoption is involved (Batel et al., 2013).

The consumer usage and the use of technologies by the consumers have been vastly studied and many of the academic research studies are available. The previous studies have insights from the reasoned behavioral theories such as TPB describes about the aspects of human behaviors. To understand individual's behavior about the usage of innovation, IDT has the answer. The two; UTAUT and TAM comprehensively presented important factors of use of technology by the individuals. It is assumed that the decisions are based on rational considerations by the people and that's why individuals are called rational beings. Many of the studies have emphasized on the various rational factors impacting the acceptance of the technology whereas the irrational factors still need more consideration. Hence the current study analyzes and investigates the Islamic fintech adoption affected by the consumer usage (Social acceptance).

I-Fintech Inclusion

Financial inclusion is considered as easy, efficient and reliable access to a financial service and products with confirmation. These products and services include formal savings, bank accounts, credit facilities in cheaper form, underprivileged or lower income clusters provision of the low-cost transactions and others (Raza et al., 2015). It is believed that inequality and poverty can be reduced via financial inclusion along with economic growth. Developed countries financial systems are more inclusive compared to less or underdeveloped countries (Clarke et al., 2003).

RESEARCH METHODOLOGY

Research Method and Design

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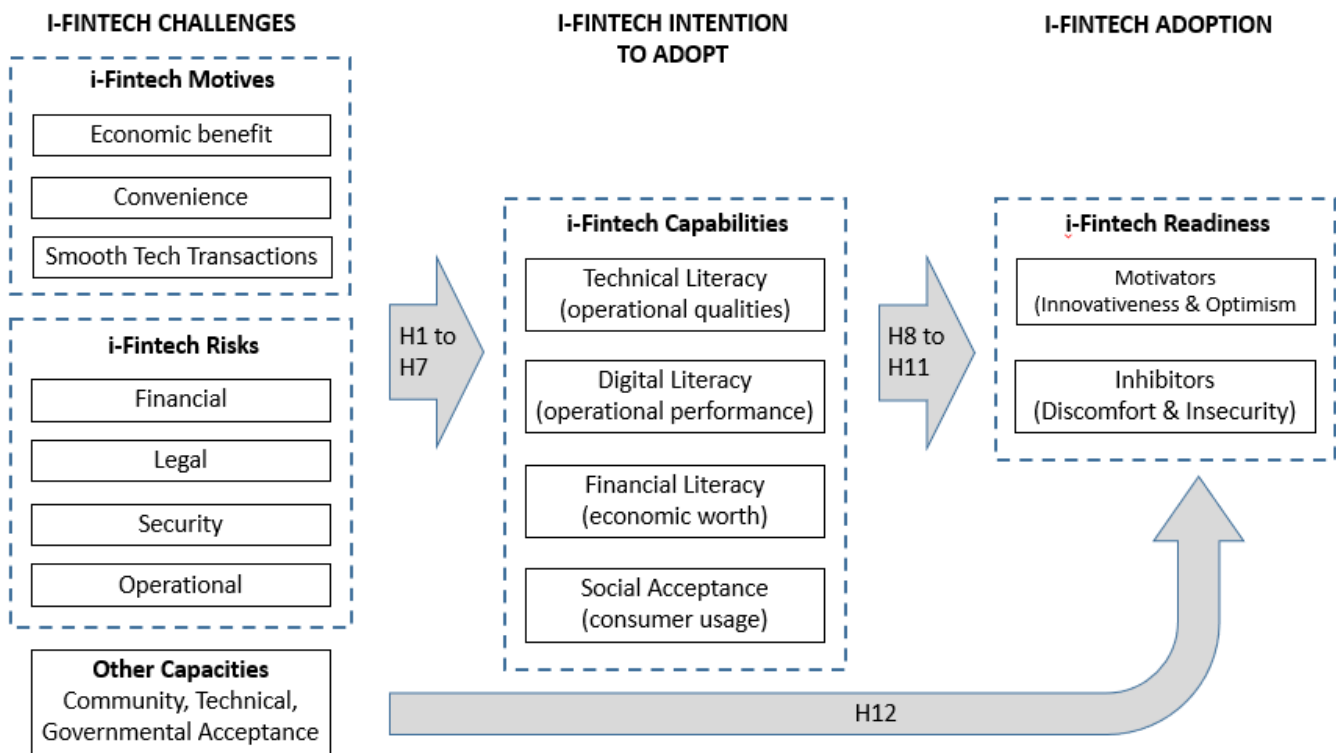


Figure 2: Research Conceptual Framework for Islamic Fintech Adoption

METHODOLOGY AND PROPOSED ANALYSIS PLAN

The proposed study is conducted through James Cook University’s (JCU’s) College of Business Law and Governance whereas the responses and data collection is performed in Pakistan using two comparative groups of banking systems. Responses from bank officials of Islamic banks and responses from bank officials of traditional banks offering Islamic banking windows. The survey data collection instrument comprises seventy quantitative response items each offering five choices (5 point Likert Scale), plus ten demographic questions. Where possible the survey instrument is delivered personally to the bank, or sent via email to more distant bank respondents. Once data is collected and collated, missing values replacement is used to correct for surveys with random, and under 20% missing values. This data set is then filed into JCU’s research online database. For increased survey form completion response rates a Dillman reminder approach (using six weekly reminders) is utilized. The number of respondents targeted is 500 plus. This allows for sectioning into SEM calibration (300+) and SEM validation (200) data sets. This study focuses on the quantitative and multifactor structural equation modelling as its key analysis methodology.

RESULTS AND DISCUSSIONS

Most interpretation and analysis is typically performed in two phases where data analysis is done first with SPSS. The initial demographic details are processed and analyzed with SPSS. Next the Cronbach alpha is found for each individual factor captured within the study. Descriptive analysis and interpretation of exploratory analysis is performed. PLS-SEM is used as second phase using factors to build a causal model as shown above in Figure 2.

Recently, financial digital inclusion in Pakistan is very low and typically aligned towards least financial inclusive countries. According to Shahid et al. (2017) the percentage of Pakistan population lacking financial services is 85%. This indicates Pakistan banks likely need to commit considerable revenue to build their banking and digital infrastructure, and train their bank users into adopting an I-Fintech approach. These scale and reach problems likely can resolve using digital financial servicing, and their associated inbuilt capabilities. Further, ninety two per cent (92%) of senior executives, and 80% of middle managers, illustrated in 2016 that Fintech likely helps emerging markets with low rates of financial inclusion to better join the financial services sector. Thus, this survey, and analysis study approach is designed to show the key contributors to delivering I-Fintech adoption.

EXPECTED CONTRIBUTION OF THIS RESEARCH

Pakistan is a growing and attractive space for Fintech companies. It also has large software house development capabilities which can support I-Fintech development. The expected contribution of this study comes from analysis and investigation of Islamic finance firms - from the perspective of challenges, risks and other issues, and across processes of inclusion and

diffusion, and their net competitiveness impact. The proposed framework of this study (illustrated in Figure 2) provides understanding of the stage wise progress for adoption of I-Fintech. Figure 2 releases factors contributions and relative strength pathways showing relative levels of challenges, risks and capabilities involved in delivering I-Fintech adoption. This model and its measures help Islamic banks and Fintech startups in Pakistan understand where to focus, and to what degree to focus, when initiating various contributing factors as model deliverers for their I-Fintech adoption.

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Impact of e-HRM system on employee performance

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ABSTRACT

This paper focused on understanding the use of an e-HRM system by employees and investigating employee performance. This paper adapted and developed the research model with theoretical frameworks from the information systems success model (IS success model) and the expectation-confirmation model (ECM). Data was collected by questionnaire from 350 samples, all employees over age 20 working currently or in the past, with willingness to accept jobs in different types of companies. Samples also had experience with using e-HRM by e-recruiting and selection, e-training and development, e-compensation and benefits, or e-performance management. Data was analyzed by confirmatory factor analysis and the structural equation model (SEM). Results were that system quality and perceived usefulness positively affected user satisfaction and there was a positive relationship between confirmation of expectations and perceived usefulness. In addition, service quality and user satisfaction were predictors of e-HRM use and information quality was a strong determinant of user satisfaction and e-HRM use. Finally, e-HRM use was a major influence on employee performance. These findings may help organizations better understand functions, features, and modules most frequently employed by e-HRM users.

Keywords: e-HRM System, Employee Performance, IS success model, Expectation-Confirmation Model.

INTRODUCTION

Today, many organizations are faced with digital disruption due to the Novel Coronavirus 2019 (COVID-19) pandemic. Social distancing and work from home are the optimal choice for most organizations to prevent the spread of this disease. Moreover, digital disruption also has become a catalyst for digital transformation of many organizations. Information Technology; for example, cloud computing, autonomous system, and Internet of Things (IoTs), plays a major role in being digital. Consequently, organizations need to find a solution to manage human capital management; for instance, remote work, delegation, human resource activities, and employee performance tracking. An e-HRM system is a great tool for human resource management during COVID-19 outbreak because any employee can access the services of HR activities via online or self-service system anywhere and anytime.

There is an impact of the e-HRM system on human resource practices greatly. In the past, human resource job was related to paper-based work (Stone & Dulebohn, 2013). Latterly, emerging of the e-HRM system in terms of web-based technology had made massive changes in human resource management since 1990. Some face-to-face HR activities were replaced with the system (Ruël, Bondarouk, & Van der Velde, 2007). In other words, the day-to-day HR activities were replaced by autonomous or self-service system. HR Department was an important player driving organizations to be digital, not to do digital (Deloitte, 2017). The e-HRM system was one of the digital HR tools to help organizations create a competitive advantage (Marler, 2009; Parry, 2011), reduce costs, and improve HR services (Bondarouk & Ruël, 2009).

Although an evaluation of e-HRM system success has been studied in the literature, most of the studies were conducted by examining technology adoption based on the perception of Technology-Organization-People (Bondarouk, Parry, & Furtmueller, 2017); for instance, ease of use, (Haines & Petit, 1997), sector (Tomeski & Lazarus, 1974), and top management support (Hannon, Jelf, & Brandes, 1996). Furthermore, a myriad of researchers studied about consequences of e-HRM including operational consequences, namely administrative burden reduction and payroll (Ruël, Bondarouk, & Looise, 2004), relational consequences; for example, communication (Panayotopoulou, Vakola, & Galanaki, 2007), and transformational consequences; for instance, strategic re-orientation (Lepak & Snell, 1998; Ruël et al., 2004).

Therefore, the purpose of this paper is to evaluate the post-adoption impact of the e-HRM system. This research aims to study e-HRM system success supporting HR activities, and the impact of the e-HRM system on employee performance. This work states the following questions: (a) Which factors can describe the antecedents of e-HRM use and user satisfaction? (b) What are the effects of the e-HRM system on employee performance?

LITERATURE REVIEW

e-HRM (electronic Human Resource Management)

Some scholars attempted to define what e-HRM was. Strohmeier (2007) defined the e-HRM as a planning, implementation, and application of information technology that networked and assisted work between at least two people or collective actor for achieving their HR activities. Moreover, Bondarouk and Ruël (2009) also gave a definition of e-HRM which was an umbrella

term regarding the linkage between human resource management and information technology. It aimed to create internal and inter-organization value for employees and managements. In addition, e-HRM also was described as a process of building human resource strategies, policies, and practices in organizations towards the full utilization of web-technology-based channels (Ruël et al., 2004). We, thereby, referred e-HRM as information systems linking and integrating HR activities amongst various stakeholders without the limitation of space and time for achieving the organization's goals.

IS success model of DeLone and McLean

DeLone and McLean (1992) proposed an original IS success model in 1992 which comprised six dimensions indicating the success of information systems: system quality, information quality, use, user satisfaction, individual impact, and organizational impact. In 2002, they updated their original model by including a new construct, like service quality, which was a critical variable in marketing studies. There was also another update to the model that was a replacement of individual impact and organizational impact with net benefits due to the beneficial purpose of multiple levels of analysis (DeLone & McLean, 2003). In addition, DeLone and McLean (2003) also described each of the six main success dimensions of their revised model as follows. Firstly, system quality was desirable characteristics of an information system. For instance, ease of use, functionality, system reliability, system flexibility, portability, availability, adaptability, and response time. Secondly, information quality was defined as desirable characteristics of the system output. For example, relevance, understandability, completeness, and security. Thirdly, the quality of the service or support that system users obtained from IS department and IT support personnel was the definition of service quality, namely responsiveness, reliability, empathy, and assurance. Fourthly, system use was described as the degree in which users utilized the full capabilities of an information system measured by navigation patterns, number of site visits, amount of use, frequency of use, and nature of use. Fifthly, user satisfaction was explained as users' level of satisfaction with reports, Web sites, and support services. Finally, the extent to which IS were causing to the success of individuals, groups, organizations, industries, and nations was an explanation of net benefits; for instance, to enhance decision support, and to increase productivity.

The e-HRM system, linking HR activities and employees in organizations, was one type of information systems. According to the purpose of this study, we developed the theoretical framework based on the prior studies of IS success. DeLone and McLean's IS success model (2003) argued that there were six major success dimensions to evaluate the success of information systems. The existing studies (Alshibly, 2014; Jaafreh, 2017; Martins et al., 2019) proposed the research model based on the IS success model of DeLone and McLean (2003). Thus, the related relationships of the IS success model of DeLone and McLean (2003) were tested in this paper and allowed us to understand the success of the e-HRM system and its impact.

Expectation-confirmation model

Bhattacharjee (2001) proposed the expectation-confirmation model (ECM), which had its roots in the expectation-confirmation theory (ECT) of Oliver (1980), to explain the related variables of intention to continue using an IS. Importantly, the ECM posited that IS continuance intention would be determined by evaluation of users in the post-usage stage regarding confirmation of expectations, perceived usefulness, and satisfaction. Moreover, the findings of Bhattacharjee (2001) revealed that satisfaction, which was predicted by confirmation of expectations and perceived usefulness, was a motivated driver of users affecting IS continuance intention. In addition, there was a positive relationship between confirmation of expectations and perceived usefulness. Perceived usefulness also had a significant effect on continuance usage intention.

According to the ECM, it posited that satisfaction was influenced by two main factors: confirmation of expectations and perceived usefulness (Bhattacharjee, 2001). Previous studies (Min & Shenghua, 2007; Kumar & Natarajan, 2020) established the research model based on ECM in the IS context. Unlike the traditional way of managing human resource tasks, the e-HRM system was a self-service information system to handle the HR processes. Since investigating the usage of the e-HRM system by employees was one of the purposes of this study, the satisfaction of the users was a related variable to evaluate. We, thereby, adapted the ECM to explain the user satisfaction determined by perceived usefulness and confirmation of expectations.

Employee Performance

Employee performance is vital for every organization to achieve its goals. The overall success of an organization was affected by the performance of each employee derived from 3 elements (Mathis & Jackson, 2008: pp. 71-72). Firstly, it was an employee's ability, which was composed of talents, interests, and personality characteristics. Secondly, it was an effort including motivation, work ethic, attendance or turnover, and job design. The last element was organization support, namely training and development, equipment and technology, performance standards, and management and co-workers. However, a lack of one of those elements would decrease the performance of employees. Moreover, job performance was described as scalable actions, behaviour, and outcomes that link between employees and organizational goals (Viswesvaran & Ones, 2000).

Alshibly (2014) examined the perceived net benefits of the e-HRM system and found that the e-HRM system could raise the job performance and productivity of employees. Furthermore, Begum et al. (2020) also studied the improvement of employee productivity through Human Resource Information System (HRIS). It indicated that utilizing the HRIS could enhance the productivity of employees and let managers and employees concentrate more on strategic duties rather than doing HR related administrative activities. In other words, the HRIS could support employees to increase their productivity instead of using the traditional way of operating human resource activities. By implementing e-HRM, the processes of HR-related activities could

run smoothly and offer better services. It also concluded that there was an influence of e-HRM on improving the performance of employees (Nurlina, Situmorang, Akob, Quilim, & Arfah, 2020).

HYPOTHESIS DEVELOPMENT

System Quality, Information Quality, Service Quality, and User Satisfaction

According to the IS success model of DeLone and McLean (2003), system quality, information quality, and service quality were the antecedents of user satisfaction. A previous study of Halawi, McCarthy, and Aronson (2008) indicated that system quality, information quality, and service quality had a positive influence on user satisfaction. Similarly, it is consistent with the findings of Alshibly (2014). Hence, we proposed that:

Hypothesis 1 (H1): *System quality positively affects the user satisfaction.*

Hypothesis 2 (H2): *Information quality positively affects the user satisfaction.*

Hypothesis 3 (H3): *Service quality positively affects the user satisfaction.*

Perceived Usefulness, Confirmation of Expectations, and User Satisfaction

The ECM of Bhattacherjee (2001) showed that the satisfaction of users was affected by perceived usefulness and confirmation of expectations. In addition, there was a positive relationship between confirmation of expectations and perceived usefulness. Existing studies (Thiruselvi, Yusliza, Ramayah, & Nur Zahitah, 2013; Kumar & Natarajan, 2020; Hung, Talley, Kuo, & Chiu, 2021) based on ECM in many contexts also found positive relationships amongst confirmation of expectations, perceived usefulness, and satisfaction of users. Thus, we proposed that:

Hypothesis 4 (H4): *Perceived usefulness positively affects the user satisfaction.*

Hypothesis 5 (H5): *Confirmation of expectations positively affects the user satisfaction.*

Hypothesis 6 (H6): *Confirmation of expectations positively affects the perceived usefulness.*

System Quality, Information Quality, Service Quality, and e-HRM Use

DeLone and McLean (2003) revealed that usage of information systems was derived from system quality, information quality, and service quality. The findings of the previous studies (Alshibly, 2014; Jaafreh, 2017; Martins et al., 2019) also illustrated the significant effect of system quality, information quality, and service quality on system use. Therefore, we hypothesized that:

Hypothesis 7 (H7): *System quality positively affects the e-HRM use.*

Hypothesis 8 (H8): *Information quality positively affects the e-HRM use.*

Hypothesis 9 (H9): *Service quality positively affects the e-HRM use.*

User Satisfaction and e-HRM Use

The DeLone and McLean's IS success model (2003) established a reciprocal dependence between user satisfaction and system usage. However, this paper captured the system dependence of e-HRM users; thereby, the influence of user satisfaction on e-HRM use was tested. The empirical study of Rai, Lang, and Welker (2002) found a positive effect of user satisfaction on system use that measured the users' behaviour towards information systems. It represented how users evaluated their attitude towards information systems. In other words, the more users were satisfied, the more system dependence was. It is consistent with the findings of Iivari (2005) that there was a positive relationship between user satisfaction and actual use. In addition, Baroudi, Olson, and Ives (1986) suggested that user satisfaction was an attitude of users towards information systems and system usage was viewed as behaviour by the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975). Therefore, the influence of attitude on behaviour and the impact of user satisfaction on intention to use or actual use were alike. Moreover, the usage of the system also performed the consistency in user's needs. Thus, an increase in user satisfaction should enhance system use by users. Conversely, if the system was inconsistent with the user's requirements, users would not be satisfied and avoid using the system. Accordingly, we proposed the following hypothesis:

Hypothesis 10 (H10): *User satisfaction positively affects the e-HRM use.*

e-HRM Use, User Satisfaction, and Employee Performance

System use and user satisfaction positively influenced individual impact which was an effect of the system on the behaviour of the users (DeLone & McLean, 2003). A previous study of Isaac, Abdullah, Ramayah, and Mutahar (2017) found that performance impact, namely process, knowledge acquisition, communication quality, and decision quality, was influenced by the actual usage of internet technology and the satisfaction of users. In addition, it is also coherent with the findings of Igbaria and Tan (1997) that found the evidence of the relationship amongst system use, user satisfaction, and individual performance; for example, to increase productivity and effectiveness. Hence, the following hypotheses are proposed:

Hypothesis 11 (H11): *e-HRM use positively affects the employee performance towards the e-HRM system.*

Hypothesis 12 (H12): *User satisfaction positively affects the employee performance towards the e-HRM system.*

Research Framework

According to the hypotheses, the proposed research framework is depicted in Figure 1. This paper aims to study the impact of the e-HRM system on employee performance combining theoretical framework between IS success model and expectation-confirmation model.

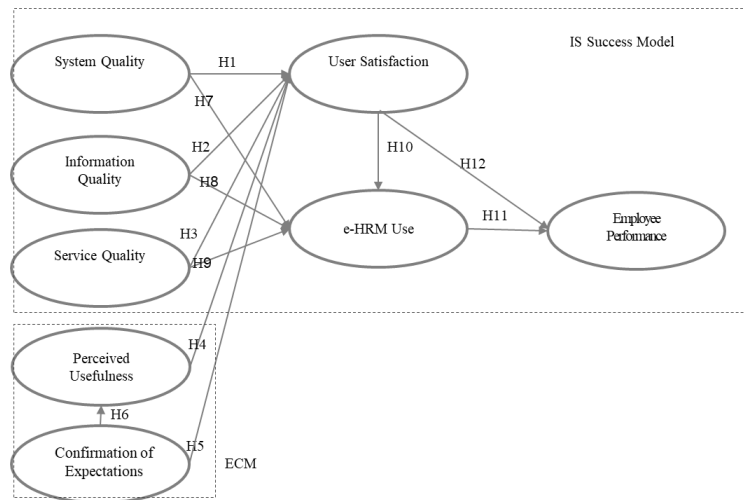


Figure 1: Proposed research model

RESEARCH METHODOLOGY

Sample Collection

The empirical data for verifying the proposed hypotheses were collected by conducting a survey in Thailand. The target samples for this research comprised employees who had experience with using the e-HRM system. We used an online survey to collect the data. Moreover, we shared the questionnaire on social media platforms, namely Facebook and Line, to approach the participants. To ensure that the respondents were actual users of the e-HRM system, the respondents were required to answer three screening questions: “Are you over 20?”, “Do you work currently or in the past, with willingness to accept jobs in different types of companies?”, and “Have you ever used the e-HRM system?”. The valid sample used to test our hypothesized model was 350 cases.

The questionnaire survey of this paper consisted of three sections. The first section of this survey had 24 question items for verifying the proposed research model including the system success and employee performance. Moreover, the second and third section of the survey included demographic questions and e-HRM system usage behavioural questions. The survey questionnaire in this study was primarily adapted from the previous studies on IS success model and the expectation-confirmation model.

Measurements

The questionnaire was developed questions derived from the literature. The variables in this study were measured on a 5-point Likert scale from strongly disagree to strongly agree. System quality (SQ) was measured by three items that reflected desirable characteristics of the e-HRM system including ease of use, availability, and response time adapted from the study of DeLone and McLean (2003). Information quality (IQ) was measured by three items that illustrated desirable characteristics of e-HRM system outputs including completeness, timeliness, and understandability adapted from the earlier studies (Bailey & Pearson, 1983; DeLone & McLean, 2003). Service quality (SVQ) was measured by three items that presented the quality of the service or support that system users obtain from support personnel for e-HRM system including responsiveness, empathy of the personnel staff, and reliability adapted from the previous studies (Pitt, Watson, & Kavan, 1995; Chang & King, 2005). Perceived usefulness (PU) was measured by three items that represented the degree to which an individual believes that there is an increase in their performance regarding HR activities by using the e-HRM system including quality of work, job performance, and job effectiveness adapted from the previous study (Davis, 1989). Confirmation of expectations (CON) was measured by three items that indicated users’ perception of the congruence between the expectation of e-HRM system use and its actual performance adapted from the study of Bhattacharjee (2001). User satisfaction (SAT) was measured by three items that showed users’ level of satisfaction with the e-HRM system adapted from the study of Seddon and Yip (1992). e-HRM use (USE) was measured by three items that demonstrated the degree in which users utilize the full capabilities of the e-HRM system including frequency of use, and system dependence adapted from the existing studies (Iivari, 2005; Bondarouk, Harms, & Lepak, 2017; Rai et al., 2002). Finally, employee performance (EP) was measured by three items that explained the effect of the e-HRM system on the behaviour of the users adapted from the previous studies, including decision effectiveness (Gable, Sedera, & Chan, 2008) and perceived performance impact (Goodhue & Thompson, 1995).

RESULTS

Demographic Characteristics and e-HRM System Usage Behaviour of the Sample

In this research, there were 350 valid cases. The descriptive analysis results of the respondents were as follow: male accounted for 50.86% while 49.14% were female. 44% of the respondents were aged 31 to 35. Most of the survey participants hold a Bachelor's degree as the highest education level accounted for 70.57%. In addition, this paper also collected data from the respondents regarding their usage behaviour of the e-HRM system. The system usage behaviour results of the participants were as follow: the majority of the survey participants' experience with using the e-HRM system was years of 6 – 10 accounted for 38.86%. Surprisingly, the functions, features, and modules that e-HRM users most frequently employed were learning and training development, payroll, time attendance, performance evaluation, and onboarding program accounted for 13.46%, 11.49%, 11.06%, 10.92%, and 9.44% respectively. The demographic characteristics and e-HRM system usage behaviour of the respondents are shown in Table 1.

Table 1: Demographic Characteristics and e-HRM System Usage Behaviour of the respondents

Category	Subcategory	Frequency	Percentage
Gender	Male	178	50.86
	Female	172	49.14
Age	20 to 25 years old	21	6
	26 to 30 years old	73	20.86
	31 to 35 years old	154	44.00
	36 to 40 years old	66	18.86
	40 to 45 years old	12	3.43
	46 to 50 years old	11	3.14
	Above 50 years old	13	3.71
Highest education level	High school diploma	18	5.14
	Bachelor's degree	247	70.57
	Master's degree	85	24.29
Year of e-HRM usage experience	Below 1 year	46	13.14
	1 to 5 year	132	37.71
	6 to 10 year	136	38.86
	11 to 15 year	34	9.71
	16 to 20 year	2	0.57
Functions, features, and modules most frequently employed by e-HRM users (can choose more than one)	Learning and Training Development	191	13.46
	Payroll	163	11.49
	Time Attendance	157	11.06
	Performance Evaluation	155	10.92
	Onboarding Program	134	9.44
	Compensation	132	9.3
	Recruitment and Selection	128	9.02
	Benefits	127	8.95
	Workforce Management	97	6.84
	Career Planning and Development	69	4.86
	HR Report	66	4.65

Confirmatory Factor Analysis (CFA)

In this paper, Confirmatory Factor Analysis (CFA) was performed by AMOS software for evaluating all variables of the proposed model. The results of the goodness of fit test demonstrate in Table 2. The goodness of the model's fit in accordance with the recommended value of Schumacker and Lomax (2010) tested by Chi-square Statistic, χ^2/df (Chi-square/Degree of freedom), Goodness-of-fit index (GFI), Adjusted Goodness-of-fit index (AGFI), Comparative Fit Index (CFI), Root-mean-square residual (RMR), Root-mean-square error of approximation (RMSEA), Tucker–Lewis Index (TLI), and Normed fit index (NFI) indicated that the model reached the acceptable value and fit very well.

Table 2: The results of the goodness of fit test

Fitting Index	Reference	Measured Value
Chi-square Statistic	p-value \geq 0.05	0.183
Chi-square/Degree of freedom	< 2.0	1.126
Goodness-of-fit index (GFI)	> 0.95	0.974
Adjusted Goodness-of-fit index (AGFI)	> 0.90	0.923
Comparative Fit Index (CFI)	> 0.95	0.998
Root-mean-square residual (RMR)	< 0.05	0.036
Root-mean-square error of approximation (RMSEA)	< 0.05	0.019
Tucker–Lewis Index (TLI)	> 0.95	0.993
Normed fit index (NFI)	> 0.95	0.979

Construct Validation and Reliability Estimation

To evaluate the construct validity, it could be tested by standardized loading estimates (λ) value of the latent variables that all items should be greater than 0.70. Moreover, Average Variance Extracted (AVE) based on a squared root of standardized loading estimates could measure the convergent validity or internal consistency of the variables which their values should be at least higher than 0.5. In addition, both Maximum Shared Variance (MSV) and Average Shared Variance (ASV) should be lower than AVE to verify the validity. Composite Reliability (CR) reflected the reliability estimation for a construct which the acceptable value of CR was higher than 0.7 (Hair, Black, Babin, & Anderson, 2010). Discriminant Validity that indicated the distinction amongst the constructs could be observed by comparing the value of shared variance between each variable and the squared root of AVE values in accordance with the criterion of Fornell and Larcker (1981) suggested that the squared root of AVE of each variable should be greater than the correlation involving the construct. Table 3 illustrates the tests of convergent validity, discriminant validity, and composite reliability of the proposed model. Furthermore, Table 4 displays the correlation matrix and discriminant validity. The results showed that all variables achieved every indicator of construct validation and reliability estimation by assessing the loading estimates, AVE, and CR.

Table 3: The tests of convergent validity, discriminant validity, and composite validity

Construct	Items	Standardized loading estimates (λ)	CR	AVE	MSV	ASV
SQ	SQ1	0.727	0.753	0.689	0.225	0.073
	SQ2	0.772				
	SQ3	0.627				
IQ	IQ1	0.798	0.760	0.506	0.446	0.192
	IQ2	0.562				
	IQ3	0.777				
SVQ	SVQ1	0.897	0.916	0.519	0.446	0.217
	SVQ2	0.879				
	SVQ3	0.880				
CON	CON1	0.961	0.903	0.784	0.126	0.024
	CON2	0.824				
	CON3	0.817				
PU	PU1	0.716	0.788	0.553	0.077	0.037
	PU2	0.754				
	PU3	0.760				
SAT	SAT1	0.943	0.881	0.757	0.219	0.097
	SAT2	0.924				
	SAT3	0.638				
USE	USE1	0.734	0.868	0.717	0.429	0.209
	USE2	0.852				
	USE3	0.895				
EP	EP1	0.851	0.817	0.599	0.434	0.203
	EP2	0.740				
	EP3	0.725				

Note: CR>0.7; AVE > 0.5; MSV < AVE; ASV < AVE.

Table 4: Correlation matrix and discriminant validity

Construct	SQ	IQ	SVQ	CON	PU	SAT	USE	EP
SQ	0.711							
IQ	0.265	0.720						
SVQ	0.297	0.668	0.885					
CON	0.078	0.355	0.078	0.870				
PU	0.232	0.277	0.190	0.115	0.744			
SAT	0.152	0.345	0.365	0.033	0.170	0.847		
USE	0.215	0.581	0.613	0.118	0.210	0.468	0.830	
EP	0.474	0.412	0.659	0.019	0.098	0.392	0.655	0.774

Tests of Hypothesis

Testing the proposed research model, Structural Equation Model (SEM) was performed by employing AMOS software in this paper. As shown in Table 5, the results of the goodness of fit test indicated that the proposed model was fit very well in accordance with the recommended value of Schumacker and Lomax (2010) tested by Chi-square Statistic, χ^2/df (Chi-square/Degree of freedom), Goodness-of-fit index (GFI), Adjusted Goodness-of-fit index (AGFI), Comparative Fit Index (CFI), Root-mean-square residual (RMR), Root-mean-square error of approximation (RMSEA), Tucker–Lewis Index (TLI), and Normed fit index (NFI). The indicators also showed that the results of the goodness of fit test of SEM reached the acceptable value. In other words, it was consistent between empirical data and the hypothesized research model in this paper.

Table 5: The results of the goodness of fit test of SEM

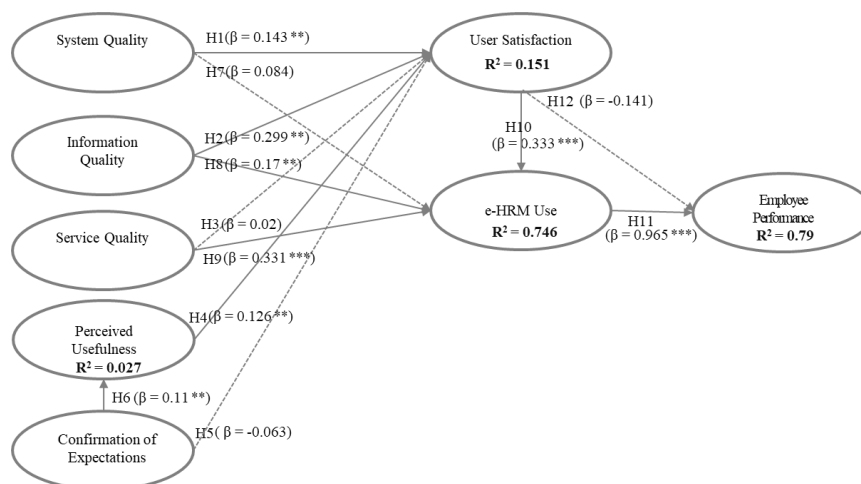
Fitting Index	Reference	Measured Value
Chi-square Statistic	p-value \geq 0.05	0.071
Chi-square/Degree of freedom	< 2.0	1.218
Goodness-of-fit index (GFI)	> 0.95	0.973
Adjusted Goodness-of-fit index (AGFI)	> 0.90	0.918
Comparative Fit Index (CFI)	> 0.95	0.996
Root-mean-square residual (RMR)	< 0.05	0.046
Root-mean-square error of approximation (RMSEA)	< 0.05	0.025
Tucker–Lewis Index (TLI)	> 0.95	0.988
Normed fit index (NFI)	> 0.95	0.978

The results of the tests of hypotheses in this paper are shown in Table 6. Moreover, the results of the model verification are illustrated in Figure 2 including coefficients and their significance of the structural model estimations. As shown in Table 6 and Figure 2, the path coefficient of the research model demonstrates that most of the proposed hypotheses in this study are supported, except H3, H5, H7, and H12. Particularly, system quality ($\beta = 0.143$, $p < 0.05$), information quality ($\beta = 0.299$, $p < 0.05$), and perceived usefulness ($\beta = 0.126$, $p < 0.05$) could predict user satisfaction, confirming H1, H2 and H4. However, the effect of service quality ($\beta = 0.02$, $p > 0.05$) and confirmation of expectations ($\beta = -0.063$, $p > 0.05$) on the satisfaction of users is insignificant, rejecting H3 and H5. In addition, confirmation of expectations ($\beta = 0.11$, $p < 0.05$) is a predictor of perceived usefulness, supporting H6. Furthermore, information quality ($\beta = 0.17$, $p < 0.05$), service quality ($\beta = 0.331$, $p < 0.001$), and user satisfaction ($\beta = 0.333$, $p < 0.001$) are determinants of e-HRM use, confirming H8, H9, and H10. On the other hand, system quality ($\beta = 0.084$, $p > 0.05$) has no significant effect on e-HRM use, rejecting H7. Finally, although employee performance is influenced by e-HRM use ($\beta = 0.965$, $p < 0.001$), supporting H11, user satisfaction ($\beta = -0.141$, $p > 0.05$) does not affect the performance of the employees, rejecting H12. To conclude, the R^2 values are 0.151, 0.027, 0.746, and 0.79 for user satisfaction, perceived usefulness, e-HRM use, and employee performance, respectively. In other words, 15.1% of the user satisfaction, 2.7% of the perceived usefulness, 74.6% of the e-HRM use, and 79% of the employee performance are explained by the related variables.

Table 6: The results of the tests of hypotheses

Hypothesis	Dependent Variable	Independent Variable	Estimate β (path coefficient)	SE	CR (t-value)	p-value	Result
H1	User Satisfaction	← System Quality	0.143	0.07	2.026	0.043**	Support
H2	User Satisfaction	← Information Quality	0.299	0.12	2.421	0.015**	Support
H3	User Satisfaction	← Service Quality	0.02	0.07	0.264	0.792	Not Support
H4	User Satisfaction	← Perceived Usefulness	0.126	0.06	2.03	0.042**	Support
H5	User Satisfaction	← Confirmation of Expectations	-0.063	0.06	-1.125	0.26	Not Support
H6	Perceived Usefulness	← Confirmation of Expectations	0.11	0.04	2.834	0.005**	Support
H7	e-HRM Use	← System Quality	0.084	0.06	1.42	0.156	Not Support
H8	e-HRM Use	← Information Quality	0.17	0.07	2.327	0.02**	Support
H9	e-HRM Use	← Service Quality	0.331	0.05	6.43	0.000**	Support
H10	e-HRM Use	← User Satisfaction	0.333	0.09	3.635	0.000**	Support
H11	Employee Performance	← e-HRM Use	0.965	0.11	8.676	0.000**	Support
H12	Employee Performance	← User Satisfaction	-0.141	0.11	-1.288	0.198	Not Support

Note: ** p-value < 0.05, ***p-value < 0.001



Note: ** p-value < 0.05, ***p-value < 0.001

Figure 2: The results of the model verification

DISCUSSION AND CONCLUSION

This research is principally concentrated on combining IS success model of DeLone and McLean with expectation-confirmation model to highlight how users evaluate the impact of e-HRM system on employee performance in the context of human resource management. Several major findings from the analysis results drive interesting discussions as follows.

Firstly, system quality has a positive effect on user satisfaction. This result is in line with the DeLone and McLean's IS success model (2003) and several previous studies (Rai et al., 2002; Iivari, 2005; Halawi et al., 2008; Alshibly, 2014). It reflects the fact that e-HRM users are worried about the desirable characteristics of the system. Hence, providing great quality of the system including ease of use, availability, and response time has a significant role in increasing users' satisfaction towards the e-HRM system. However, the relationship between system quality and e-HRM use is not significant, which is incoherent with the IS success model of DeLone and McLean (2003) and the conclusion of some existing studies (Rai et al., 2002; Iivari, 2005; Halawi et al., 2008; Alshibly, 2014). It could be possibly explained that using the e-HRM system does not require much effort from users because they can easily access the features, functions, and modules that they would like to employ. In other words, users know how to utilize the system very well. Thus, system quality does not affect the usage of the e-HRM system.

Secondly, the influences of information quality on both satisfaction and e-HRM use are significantly positive, which is coherent with the IS success model of DeLone and McLean (2003) and similar to the findings of the previous researches (Rai et al., 2002; Halawi et al., 2008; Alshibly, 2014; Jaafreh, 2017). Essentially, information quality is the strongest determinant of user satisfaction ($\beta = 0.299$) amongst the three dimensions of the DeLone and McLean's IS success model. Therefore, these findings underline the remarkable role of information quality in boosting usage and especially the satisfaction of users towards the e-HRM system. Thus, if the e-HRM system can provide the information in terms of completeness, timeliness, and understandability, users will be more satisfied and utilize the system intensively.

Thirdly, there is no positive effect of service quality on user satisfaction, which is opposed to the conclusion of the previous studies (Halawi et al., 2008; Alshibly, 2014; Jaafreh, 2017; Martins et al., 2019). One possible explanation could be that users might not have a lot of experience in contacting with support personnel or being serviced by support personnel. Service quality obtained from support personnel; thereby, becomes insignificant for the satisfaction of users. Unlike satisfaction, the effect of service quality on e-HRM use is significant, which is conforming to the findings of the existing studies (Alshibly, 2014; Jaafreh, 2017; Martins et al., 2019). It could be inferred from these results that if the support personnel of the e-HRM system provides great willingness to help, personalized attention, and proper solutions to users, their usage will increase markedly.

Fourthly, confirmation of expectations is not a positive indicator of the satisfaction of users. This finding is inconsistent with the ECM of Bhattacherjee (2001). It is also not similar to the conclusion of the previous studies (Thiruselvi et al., 2013; Kumar & Natarajan, 2020; Hung et al., 2021) that the confirmation of expectations was a motivated driver of user satisfaction. The possible explanation is that the expectations of users have changed over time. Moreover, the e-HRM system might not provide unexpected services or services beyond users' expectations. Thus, confirmation of expectations does not positively affect user satisfaction. However, the perceived usefulness of users is found to be positively affected by expectations' confirmation, which is consistent with the finding of the previous studies (Bhattacherjee, 2001; Thiruselvi et al., 2013; Kumar & Natarajan, 2020; Hung et al., 2021). In other words, if users' expectations; for example, experience with using the system, and service level provided by the system, are better than they expect or confirmed, they will strongly believe that the e-HRM system is helpful.

Fifthly, this paper allows us to realize that perceived usefulness is a significant antecedent of user satisfaction, which verifies the original conclusion of Bhattacherjee (2001). Similarly, the earlier studies (Thiruselvi et al., 2013; Kumar & Natarajan, 2020; Hung et al., 2021) also support that there is a positive relationship between perceived usefulness and user satisfaction. It

indicates that if users have perceptions of beneficial experience with using the e-HRM system, they will feel more satisfied. It also represents that the more users perceive the e-HRM system as useful, the more presumably they are delighted.

Sixthly, there is a significant positive effect of user satisfaction on e-HRM use, which is consistent with the conclusion of DeLone and McLean (2003). Importantly, this finding emphasizes that user satisfaction is the strongest predictor of e-HRM use ($\beta = 0.333$) amongst the antecedents of this study. Hence, this result points out the critical role of user satisfaction in predicting e-HRM usage by employees. However, the satisfaction of users is not a determinant of employee performance. This result is incoherent with the finding of the existing studies (Igarria & Tan, 1997; Isaac et al., 2017). The possible reason why there is no positive relationship between user satisfaction and employee performance is that the users already have a positive attitude towards the e-HRM system. As a result, this finding reveals that user satisfaction does not have a significant effect on enhancing employee performance towards the e-HRM system.

Finally, e-HRM use has a positive influence on employee performance towards the e-HRM system, which is coherent with the findings of the existing studies (Igarria & Tan, 1997; Isaac et al., 2017). This result addresses the crucial role of e-HRM usage in enhancing employee performance. It could be inferred from these results that if users or employees utilize the e-HRM system intensively or rely on the system, their performance, namely decision making, productivity, and efficiency, will be increased. In addition, the results confirm that e-HRM use is positively affected by user satisfaction and there is a significant effect of e-HRM use on employee performance towards e-HRM system. Thus, it could be implied that the satisfaction of users indirectly affects employee performance through the usage of the e-HRM system.

CONTRIBUTIONS AND IMPLICATIONS

Theoretical Implications

This paper contributes to the progression of developing a theoretical framework related to e-HRM system success and employee performance in several ways. Firstly, this research is one of the studies which try to explore the key predictors of employee performance involving the e-HRM system from the views of IS success model and ECM. Most of the existing studies attempted to investigate e-HRM system adoption (Tomeski & Lazarus, 1974; Hannon et al., 1996; Haines & Petit, 1997) and its consequences (Lepak & Snell, 1998; Ruël et al., 2004; Panayotopoulou et al., 2007). However, this research aims to examine the performance of employees towards the e-HRM system and its values. It also introduces an empirical study of verifying the integrated model from those two frameworks which are expected to propose a deeper understanding of the antecedents of e-HRM system success and employee performance. Moreover, most of the relationships amongst the proposed model in this paper are confirmed, which is valid for the reason why we combined the IS success model with ECM as the theoretical foundation. Undoubtedly, the explanatory power of the integrated model can explain 15.1% of the observed variance in user satisfaction. These findings still motivate other researchers to recognize the IS success model and the ECM in future work on employee performance concerning other information systems or contexts.

Secondly, user satisfaction and system use have proven to be the critical determinants of individual impact in many contexts (Igarria & Tan, 1997; Rai et al., 2002; Halawi et al., 2008; Alshibly, 2014); however, there was limited research which investigated its role in the context of e-HRM system. This paper sheds new light on the influence of user satisfaction and usage in enhancing employee performance towards the e-HRM system. Thus, future research on e-HRM system success and its impact on employee performance should not exclude user satisfaction and system use in predicting employee performance towards the e-HRM system.

Finally, this research enriches our understanding of employee performance in the context of information systems related to HR. Human capital management is having a digital transformation towards automated and data-driven HR processes and is presently concentrating on improving employee performance by deploying digital HR technology. The empirical research on enhancing employee performance towards the e-HRM system in the post-adoption stages still is limited despite the fact that most organizations could take advantage of implementing the e-HRM system. According to the theoretical basis of IS success model and ECM, this paper offers a deeper insight into the perception of employees in the post-adoption stage towards the e-HRM system and its relevant HR functions, features, and modules.

Practical Implications

By deploying of e-HRM system, most organizations are advantageous for the HR processes and the employee performance. These findings can provide a valuable guideline for many organizations in developing practical solutions to encourage employees' e-HRM usage and improve employee performance. This research illustrates that the performance of employees will be improved only if they utilize the e-HRM system intensively and perceive its performance impact. Moreover, organizations should also pay close attention to the satisfaction of employees and the perspectives of e-HRM system's quality.

Firstly, satisfying employees' concerns is a top priority of organizations to determine e-HRM system success and boost the e-HRM usage of employees heavily. Thus, organizations will achieve their goals regarding the success of e-HRM system only if users are satisfied with the system performance and have a positive attitude towards the system. Because information quality plays a vital role in user satisfaction and e-HRM use, the e-HRM system must provide employees with information, which is completeness, timeliness, and understandability. Therefore, high-quality information provided to employees by the e-HRM system will allow them to be satisfied greatly and they will utilize the system intensively. In addition, service quality is also

another critical determinant of e-HRM use showing that support personnel needs to be always greatly willing to help the users. Paying individualized attention and providing appropriate solutions to users are also a pleasant service quality of support personnel that could drive the usage of the e-HRM system increasingly. Moreover, system quality is a predictor of user satisfaction. This finding emphasizes the preferable quality of the e-HRM system that users are concerned about. Therefore, it recommends that the e-HRM system should offer high system quality with uncomplicated usage, high availability, and immediate response time to make users feel satisfied. Since perceived usefulness has a positive effect on user satisfaction, organizations should ensure that employees realize the e-HRM system as a helpful tool that can finish their HR-related work effortlessly. Although confirmation of expectations acts as an essential driver of perceived usefulness, user satisfaction is not positively affected by expectations' confirmation. However, it could be implied that confirmation of expectations indirectly influences user satisfaction through perceived usefulness. These findings suggest that if the expectations of users towards the e-HRM system are confirmed, they will recognize the system as a useful platform for their HR-related tasks. Thus, the level of user satisfaction will be increased dramatically if organizations could secure that users' expectations are confirmed or fulfilled, and they perceive the e-HRM system as being beneficial to use in facilitating their jobs regarding HR activities.

Secondly, this paper also depicts that deploying the e-HRM system enhances employee performance greatly including decision support, HR-related productivity, and efficiency of HR activities. In other words, the more users depend on the e-HRM system, the higher employee performance is. Although user satisfaction does not affect employee performance towards the e-HRM system, e-HRM use is influenced by user satisfaction. In turn, e-HRM use affects employee performance towards the e-HRM system positively. Hence, it could be inferred that user satisfaction has an indirect impact on the performance of employees through e-HRM use. Thus, this result proposes advantageous information to organizations that it would be great for improving employee performance if organizations could encourage users to intensively utilize the capacities of the system and maintain their satisfaction at an extremely high level.

Finally, this research provides an exciting insight into the study of functions, features, and modules most frequently employed by e-HRM users. According to the survey results, five functions, features, and modules of the e-HRM system most frequently utilized by e-HRM users are learning and training development, payroll, time attendance, performance evaluation, and onboarding program, respectively. By demonstrating that the aforementioned functions, features, and modules are highly popular or relevant to e-HRM users because the users utilized them frequently, our findings suggest that implementing the e-HRM system in any organization should be concerned with whether there are the functions, features, and modules of the e-HRM system that users expect or not. Additionally, it might be able to say that those functions, features, and modules could be essential for users to employ the e-HRM system frequently or provide the appropriate solution to users' requirements.

LIMITATIONS AND FUTURE RESEARCH

In summary, the results show that system quality, information quality, and perceived usefulness positively affect user satisfaction; however, service quality and confirmation of expectations are not predictors of user satisfaction. In addition, the positive relationship between confirmation of expectations and perceived usefulness is confirmed. Moreover, system quality does not have a significant effect on e-HRM use. Unlike system quality, e-HRM use is found to be positively affected by information quality, service quality, and user satisfaction. Finally, the influence of e-HRM use on employee performance is significantly positive, whereas user satisfaction is not a determinant of employee performance.

Although the e-HRM system has received much attention from scholars and the business sectors during the COVID-19 pandemic, existing studies have not been conducted in Thailand so far. The e-HRM system is a human capital management tool for operating and maintaining HR activities. The e-HRM system plays a critical role in increasing employee performance concerning decision making, HR-related productivity, and HR activities' efficiency. By developing a research model with theoretical frameworks from IS success model and ECM, this paper could explain how to evaluate the e-HRM system success and the impact of the e-HRM system on employee performance. The findings of this study recommend that organizations need to leverage factors affecting user satisfaction, e-HRM use, and employee performance towards the organization's e-HRM system to build a plan that contributes to an efficient human capital management and an improvement of employee performance.

Even though this paper has several limitations, it could inspire some opportunities for other scholars and future works. Firstly, approximately half of the survey respondents have over six years of experience with using the e-HRM system. Since the e-HRM users with different years of experience with employing the e-HRM system might have different expectations and hold different attitudes towards the e-HRM system, it might impact the applicability of our proposed model and findings. Secondly, 2.7% of the perceived usefulness is explained by confirmation of expectations. Thus, this result demonstrates that there is a high error in the relationship between confirmation of e-HRM users' expectations and perceived usefulness. Therefore, the generalizability of this study needs to be done carefully.

Finally, our research concentrates on investigating e-HRM system success and the impact of the e-HRM system on employee performance; however, it could extend the study by adapting more additional theoretical framework based on our proposed research model. We suggest that future works might include the task-technology fit model (TTF) of Goodhue and Thompson (1995) to extend the present research model. It could further explain how the fit between technology and users' task leads to employee performance. The linkage between the task-technology fit which consists of task and technology characteristics, e-

HRM utilization, and the performance impact of employees has not been investigated. A significant gap and scholarly opportunities for future study remain. In addition, future research could also be examined in different levels of analysis, from the individual level of analysis to the organizational level of analysis, in order to measure e-HRM system success and its organizational impact or performance. The Balanced Scorecard of Kaplan and Norton (1992) could be adapted to future work based on our proposed research model. It could measure organizational performance from not only a financial perspective but also non-financial perspectives regarding customer, internal process, and learning and growth. Those indicators could assess the value of an organization's investment in the e-HRM system.

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Improving spam filtering in enterprise email systems with blockchain-based token incentive mechanism

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ABSTRACT

Spam has caused serious problems for email systems. To address this issue, numerous spam filter algorithms have been developed, all of which require extensive training on labeled spam datasets to obtain the desired filter performance. However, users' privacy concerns and apathy make it difficult to acquire personalized spam data in real-world applications. When it comes to enterprise email systems, the problem worsens because enterprises are extremely sensitive to the possible disclosure of confidential information during the reporting of spam to the cloud. Targeting these obstacles, this study proposes a blockchain-based token incentive mechanism, with the aim of encouraging users to report spam while protecting business secrets and ensuring the transparency of reward rules. The proposed mechanism also enables a decentralized ecosystem for token circulation, fully utilizing the advantages of blockchain technologies. We developed a prototype of the proposed system, on which we conducted a user experiment to verify our design. Results indicate that the proposed incentive mechanism is effective and can raise the probability of spam reporting by more than 1.4 times.

Keywords: Spam Filtering; Blockchain; Token Incentives; User experiment.

INTRODUCTION

Spam is a serious concern for email systems. According to the Spam and Phishing Analysis Report published by Kaspersky, 45.47% of global email traffic in the third quarter of 2021 was spam. Situation becomes even worse in the email systems of large organizations and enterprises, due to the public nature of their email addresses (Lee & Chang, 2021; Wood & Krasowski, 2020). According to the Coremail Enterprise Email Security Report, the number of spam emails identified in enterprises reached 760 million in the fourth quarter of 2021, and the total number of phishing emails increased by 95.43% year-on-year. Obviously, anti-spam is of great practical significance, and many email service providers are developing automatic spam filtering algorithms.

Spam filtering algorithm can identify and filter spams on basis of training on a large scale of labeled spam datasets but collecting training data is difficult. Many filtering algorithms are reported to reach high accuracy on the open spam dataset for testing purposes (Shrivastava et al., 2021). When it comes to real applications, however, most spam data is gathered through the traditional method of manually annotating. Furthermore, the strict privacy protection requirements prevent email service providers from accessing their clients' email content. In this situation, it can be difficult to ensure the quality of the spam database because of difficulties such as a lack of regular updates, a huge gap between the data and the real spams received by the user, etc. Even if the filtering algorithm is highly accurate in testing tasks, filtering services often struggle to discover new types of spam in a timely manner, resulting in a significant drop in spam filtering accuracy in real applications.

Another method for gathering training data is to ask users to report spams they have received, but the privacy concerns and apathy of users make this method impractical. Especially in enterprise email applications, some enterprise email systems even do not provide users with the feature of reporting spams to the cloud due to the concerns about the leakage of business secrets. Furthermore, email receivers are not active in reporting spam because there are no obvious incentives to do so. Therefore, a well-design mechanism for encouraging users to report spams under the premise of data security is essential, especially in the enterprise scenarios.

The wide applications of blockchain in a variety of industries inspires us to come up with a novel solution to the aforementioned issues by developing an anti-spam ecosystem with user participation. The successful adoption of blockchain-based token incentive mechanisms in decentralized autonomous organizations (DAOs) like Steemit and other blockchain-empowered communities have demonstrated their enormous potentials. As a typical example, the tokens (Steem) issued by Steemit have a total market value of more than 88 million dollars (September 2022). Most of these tokens are used to reward their users for posting or discovering high-quality content, hence boosting user engagement. Moreover, the decentralized nature of blockchain facilitates the resolution of the trust problem, thereby ensuring the security of users' digital assets on the blockchain platform.

Therefore, this paper proposes a blockchain-based token incentive mechanism to improve spam filtering in real-world applications, specifically enterprise email systems. Utilizing the most recent advancements in blockchain technology, the proposed design aims to collect more personalized labeled spam data while protecting privacy and business secrets. Users participating in the proposed mechanism, in particular, can earn token rewards for reporting spam. Tokens can be used to obtain benefits from enterprises. The enterprises then utilize the tokens they have collected to waive service fees from email service providers. The service providers pay for the fee waiver and receive updated and personalized labeled spam data in return, hence improving filtering performance. We also created a system prototype and conducted a user experiment to assess the effectiveness of our design. The results suggested that the proposed mechanism increased the likelihood of users' reporting spam by 1.4 times when compared to non-token incentives.

Following are the originality and contributions of our work: (1) We propose a novel solution to the problem of email spam using a blockchain-based incentive mechanism that focuses more on training data than on the filtering algorithm. (2) We contribute to the existing literature on blockchain applications by utilizing the decentralization property of blockchain to the scenario of enterprise email systems. (3) We construct a prototype of the proposed enterprise email system and conduct a user experiment to evaluate the efficacy of our design, with methodological implications for future empirical studies of blockchain.

RELATED WORK

Spam Filtering

Prior research on spam filtering has concentrated extensively on algorithm design. Naive Bayes, Decision Tree, and SVM are the most commonly used mail filtering algorithms (Mujtaba et al., 2018). On this basis, many researches introduce neural networks for mail recognition, such as MLP (Apoorva & Sangeetha, 2021), LSTM (Saumya & Singh, 2022), ensemble learning (Zhao et al., 2020), etc., and built recognition models that integrated multiple algorithms. Shrivastava et al. (2021) assessed the models integrating various algorithms, compared and summarized four models made up of naive Bayes, decision tree, K-NN, SVM, MLP and RF, and found that the model composed of MLP, Naive Bayes and RF had the best performance. However, these solutions have not adopted the personalized filtering strategy.

The personalized filtering strategy builds on the conventional mail filtering algorithm and considers heterogeneous user patterns. Since the classification of spam varies depending on the user's interests, hobbies, and usage patterns, i.e., an email may not be considered spam by one user while being considered spam by another, the personalized filtering strategy further enhances the filtering accuracy. For example, Liu et al. (2017) proposed the CPSFS filtering model that divides spam into "totally spam" - considered spam by all users, and "half spam" - considered spam by certain users, and filters spams on both the server-side and the client-side. Their experiment revealed that CPSFS was more precise than ordinary Bayesian filtering. Similarly, Chen & Xu (2018) developed a client-side mail re-filtering mechanism. In their solution, a dynamic filter was built with several time windows and self-learning methods to achieve effective filtering. In spite of its better performance, a fundamental shortcoming of the personalized filtering strategy is that it relies heavily on the availability of users' spam data.

Whatever algorithm is employed, sufficient labeled spam data is required for training the filtering algorithm. An algorithm, particularly one for personalized filtering, can only accomplish its desired filtering performance when users report receiving spam. Our effort focuses on resolving the issue of how to get spam data from users, which has received very little attention up to this point.

Applications of Blockchain

Blockchain has been adopted in many fields and has demonstrated its utility. A survey indicated that blockchain technology may strengthen information systems in terms of interoperability, efficiency, and elimination of third-party intermediary costs. (Berdik et al., 2021). When it comes to specific cases, blockchain helps ensure data security and reshapes trust transfer in supply chain management (Moosavi et al., 2021) and other applications like federal learning (Toyoda et al., 2020). In conclusion, the application of blockchain is both technological transformation and mechanism remodeling to the traditional information system.

However, there are relatively few studies in the application of blockchain in mail systems, and discussions in this field are just focused on data security. For example, when applied in email system, blockchain can enable users to send and receive emails without a trusted third party (TTL). Specifically, the mail sender in blockchain-based email system sends one key to the receiver and uploads another key to the blockchain, and receiver can only decrypt the mail when having the two keys (Hinarejos et al., 2019; Hinarejos & Ferrer-Gomila, 2020). Although blockchain has been shown to improve data security of email systems, there are many potentials of blockchain in reshaping the incentive mechanism of spam reporting in email systems, which still remain unexplored.

Blockchain-Based Token Incentives

Blockchain-based token incentives refer to the method of smartly issuing blockchain-based tokens as rewards. Many studies have summarized its distinct application value. The decentralized structure of blockchain tokens promotes user-to-user transactions by resolving the trust and privacy challenges that plague traditional centralized systems. Additionally, it facilitates the establishment of a token economy with substantial monetary value that can provide users with substantial economic returns (Thelwall, 2018), which is beneficial for online platforms to attract early users and to solve the "chicken or egg" conundrum

(Drasch et al., 2020). The following three application aspects of blockchain-based token incentives have been intensively investigated:

(1) The blockchain's decentralized structure and the automatically executed smart contract enable convenient, low-cost and secure transactions between users, meeting the needs of many fields. ImaniMehr and DehghanTakhtFooladi (2019) created a token incentive mechanism for P2P streaming media transmission so that users can gain the most benefit from donating their own network resources, hence improving the overall performance of streaming media transmission. In order to overcome the current challenges with distributed renewable energy trading and generation, Wang et al. (2019) developed a token-based incentive mechanism for distributed renewable energy, and set up a decentralized power trading system. The network resources and electricity contributed by users may be easily quantified and confirmed with very low cost.

(2) The transparency of token incentive rules and the non-tampering of blockchain data can aid in eliminating the concerns of unfairness. Gong & Fan (2019) applied token incentive mechanism to information sharing behavior in the scenario of online marketing. They linked the tokens to the users' reputation in an equitable manner to ensure the reputation's veracity and to boost the marketers' willingness and quality of information sharing. Weng et al. (2019) introduced token incentives in federated learning to provide participants with a fair guarantee to prevent participants from misleading training, inference attacks, and other improper behaviors. Experiments with simulations indicate that token incentives are more likely to induce participants to comply with rules and behave appropriately. Dang et al. (2022) developed a dynamic incentive mechanism for supervising employees in the service industry. The usage of tokens and smart contracts overcomes the fairness problem regarding whether to reward or punish employees. The experimental results indicate that this mechanism can help employees better moderate their behavior when interacting with clients.

(3) Blockchain-based token incentives are used address data security concerns. In the medical field, for example, electronic medical records can be stored on blockchain to ensure data security. On the assumption of ensuring the authenticity and privacy of experimental data and medical records, the use of a blockchain-based token reward mechanism can improve people's enthusiasm for participating in clinical trials (Jung et al., 2021).

Table 1: Application value of Blockchain-based Token Incentives

Application value of Blockchain-based Token Incentives	Literatures	Application Scenarios
Decentralized trading	ImaniMehr & DehghanTakhtFooladi, 2019	Peer-to-peer video streaming networks
	Wang et al., 2019	Market of distributed renewable energy
	Gong & Fan, 2019	Market information sharing
Addressing trust issues	Weng et al., 2019	Federated learning
	Dang et al., 2022	Supervision of employee behavior
	Jung et al., 2021	Medical trial recruitment
Data security		

In conclusion, these studies demonstrate the rationales and advancements of employing token incentives instead of traditional virtual credit incentives. However, no direct discussion on the use of token incentives in email filed has been found. These previous studies are of great reference value for us regarding the design of token incentive mechanisms for spam filtering in enterprise email systems.

TOKEN INCENTIVE MECHANISM DESIGN

Challenges of Incentive Mechanism among Different Participants

There are three roles in an enterprise mail system: user, enterprise, and mail service provider. A user is the employee who uses the enterprise email systems to handle their work. An enterprise is the organization that purchases the mail service. A mail service provider is the company that develops mail systems and offers related services. Each of the three participants has its own needs. To better show the motivation behind our blockchain approach, we will analyze the trust issues between the email service providers and their enterprise customers, followed by a discussion of the limitations of traditional monetary end-user rewards.

Service providers seek to collect more spam data by offering incentives to improve spam filtering capabilities and market competitiveness. In practice, however, service providers cannot completely trust their enterprise customers since it is difficult to assure the openness and transparency of incentive issuance regulations. In particular, when the incentive service is run locally on the enterprise side, there is no guarantee that the enterprise will not use illegal ways to modify the codes or databases to defraud rewards. From the perspective of a service provider, it is eager to take control of the incentive-related codes and databases, and it desires that the incentive service execute locally on the service provider side.

Similarly, the enterprises do not fully trust the email service providers. An enterprise, like the service provider, cannot guarantee that the provider will not change the rules and database at the backend, reducing the issuance of incentives deserved by the enterprise and its users. Moreover, many large organizations require running their mail systems locally to ensure data

security and privacy. It may be unacceptable for them to allow the email service provider to gain control of the incentive service, which may reveal some operational information of its employees. Obviously, there is a significant conflict regarding the control of the incentive sub-system between the service providers and their enterprise customers.

When it comes to the end-user side, i.e., the employees in the enterprises, in most of the traditional designs, reporting of spam is just a voluntary activity of users in order to receive more accurate filtering services. This is far from satisfactory, even with monetary incentives. Economically speaking, service providers should consider the actual cost and benefit of offering incentives. The monetary rewards obtained by every user for reporting spam would be tiny, resulting in very little incentive effect, but the total cost of the service providers can be substantial. How to lower the cost and increase the effectiveness of rewards is a crucial design challenge for incentive mechanisms.

To summarize, targeting the trust issues, a decentralized structure is required to meet the needs of the three roles in the system. This is one of our main motivations to embrace blockchain in our design. The decentralized nature of blockchain allows the operation ledger to be distributed and stored among enterprises and service providers, hence resolving the trust issue between them. The on-chain smart contract enables automatic incentive issuance execution thus ensuring the openness and transparency of incentive issuance rules. Moreover, the tradable and multi-dimensional-value natures of blockchain tokens allow us to design the incentive mechanism in an ecological manner, which can be expected to improve the efficiency.

Users' Spam Reporting and Token Incentives

The tokens circulating in the system are referred to as reporting tokens. Reporting token incentives mean that users who report valid spam are rewarded in the form of tokens. Users can obtain tokens only by reporting spam. The service provider collects the spam reported by users and awards them with tokens. The enterprise acts as the mail auditor to prevent the leak of confidential information, and it also provides the token redeeming service for its employees. Figure 1 depicts the overall reporting token incentive process.

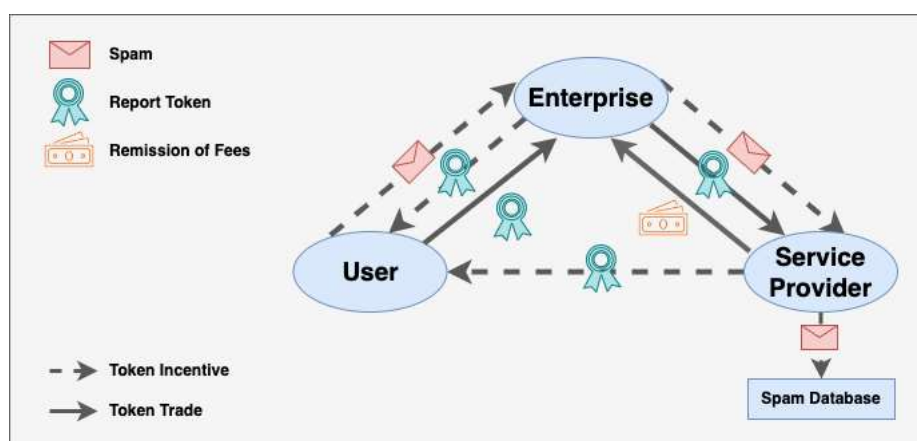


Figure 1: Process of the reporting token incentives

After receiving a spam email, a user of the enterprise notifies the enterprise via the system. After receiving the report, the enterprise examines the content of the email, confirms that it does not include any confidential information, and uploads the email to the service provider's spam database. After receiving the reported spam mail, the service provider verifies it and adds it to the enterprise's personalized filtering database or general spam database, enables the mail filtering model to do incremental training, and issues reporting tokens to the users who reported this spam.

Since the service provider would be sensitive to the actual cost of issuing token incentives, it is better to make the cost predictable and controllable. Therefore, we refer to the token issuance rules used in the online community Minds (minds.com) and adopt the model of fixed total amount and contribution weighting. Contribution weighting means that the tokens are awarded to a user based on the weight of his or her contribution. The weight is calculated as the ratio between the number of spams a user report in each period, and the total number of spams reported in the whole system in that period. Fixed amount means that service providers provide a fixed number of tokens to award users in a certain period. As a result, in a system with j users, the k th user ($k < j$) receives E tokens in a period, as shown in Equation 1, where N is the total number of tokens awarded by the service provider in a period, n_k and n_i are the number of spams reported by the k th and i th users, respectively, in this period.

$$E = N \times \frac{n_k}{\sum_{i=1}^j n_i} \quad (1)$$

With the help of the decentralized ledger of blockchain, we believe both the users and the enterprises are not able to obtain token incentives through any malicious behavior, and that all the token rewards will be distributed fairly and objectively to the contributors. One reason is because all the incentive-related processes are transparent to all the participants in the email system. Any malicious behavior can be easily traced by other participants via the blockchain ledger. A further reason is that the block

data is immutable for every single participant, making any malicious backend operations impossible, and therefore, eliminating the trust concerns among different participants. The final reason is that, following consensus among the participants, all incentive rules are codified on smart contracts that automatically distribute token rewards. The immutability and self-execution of smart contracts ensure the objectivity and fairness of token reward distribution.

To sum up, in the whole incentive mechanism, users contribute by reporting spam and receive the reporting tokens as the work certificate. Enterprises and users benefit from a more effective and individualized spam filtering service, and obtain better mail filtering performance through the continuous training of personalized filtering algorithms. Mail service providers pay the token to obtain timely and accurate spam data, achieve better mail filtering performance through the continuous training of personalized filtering algorithms, and improves the competitiveness of their products. In fact, the value of the designed incentive mechanism can be enlarged through token trading and circulating in a token-ecosystem, which will be introduced in the following.

Token Trading and Circulating

After receiving the token rewards, users can redeem them from the enterprise according to the reward-to-redemption ratio that all the participants have agreed on. Redeeming options can be advanced mail services like huge attachment cloud storage and e-mail content refinement, as well as other benefit like the eligibility for internal purchasing funds. Furthermore, by creating a ranking list of users receiving tokens and awarding medals, enterprises may also transform the token into a comprehensive incentive that integrates economy, psychology, reputation, which may enhance the incentive effect.

Enterprises obtain tokens from users and use these tokens to trade for fee waivers from the service provider. Depending on the demands in the ecosystem, the service provider may issue new tokens when existing ones are insufficient. To prevent the service provider from issuing tokens arbitrarily, the minimum exchange ratio between token and usage fee waiver can be specified, which provide the value basis for the tokens.

The service provider might revise the number of tokens issued in each period to control the cost of rewards. The enterprise can decide whether to invest additional expenses to encourage users to report spams according to a tradeoff between the inventive cost and the fee waivers. Since the value of tokens is fundamentally assured throughout the token circulation loop, enterprises and service providers may regulate their expenses flexibly, and users can receive their appropriate benefits. As a whole, the entire mechanism can function effectively.

USER EXPERIMENT

Many researchers have used the evolutionary game method to measure the effectiveness of the incentive mechanism. However, in our context, it is difficult to use rational person hypothesis and to quantify earnings of users. Noticing that user experiment is also a practical and common method for analyzing the incentive impact in information systems since the usage scenario can be easily modified and controlled (Jung et al., 2021), we decide to employ the user experiment method to evaluate the effect of the designed blockchain token incentive mechanism.

Experiment Design

The experiment referred to the possible incentive input in the real word and set three groups. Although the value of a reporting token is designed to consistently change in the incentive mechanism, we set the value of a token at 1 RMB in the experiment by altering the reward-to-token ratio to control the rewards subjects received. As a result, not only can we set groups with and without incentives to compare the incentive effect, but also set groups with certain incentive quantity to compare the incentive effect of different incentive inputs. And considering the actual incentives that enterprises and service providers may input, we set the non-incentive group, the 1 token/spam group and the 5 token/spam group in the experiment. The process of user experiment is as follows:

(1) Click on the link. The entire user experiment was conducted with PCs, including assessing the subjects' system usage behaviors and their answering of questionnaires. The experimental subjects would receive the link before the experiment and started the experiment after clicking on it. After clicking the link, participants would be randomly redirected to different versions of systems with varied parameter settings corresponding to different experimental groups. The redirections were accomplished automatically in the backend with no user intervention required.

(2) Go through the experiment instructions. The page jumped to the experiment instructions after clicking the link. By reading the description, the subjects had a basic comprehension of the aims, processes, estimated duration of the experiment, as well as the basic concepts of blockchain and tokens. The subjects entered the prototype email system after confirming that they had finished reading the instructions.

(3) Independent user exploration. The experimental subjects could freely explore the prototype system, interact with it, and accomplish operations such as viewing mails, sending mails, reporting mails, and so on. In its initial state, the email system had several mails in its bin and inbox, including two wrongly filtered mails: one was spam but recognized as non-spam, another one was non-spam but recognized as spam. By reporting wrongly filtered emails, the user could get reporting tokens. In addition, a specific email reading task was assigned based on the actual content of the email to guarantee that the subjects

used the system correctly. The subjects entered the scene of receiving a new email after confirming the completion of email reading and investigating the system functionalities.

(4) Receive new emails. The subjects received new emails, read them, and then acted on them. Three new messages were received by them: two of which were unfiltered spam and one of which was not. The user experiment terminated when the subjects affirmed that they had read the emails and completed the action. And then the browser would navigate to the questionnaire link.

(5) Complete the questionnaire. The questionnaire comprised three questions and used a five-level scale to assess the strength of incentives users perceived in order to investigate their subjective perceptions of incentive effect.

Table 2 The Questionnaire of Perceived Incentive Strength

Variables	Number	Questions
Perceived Incentive Strength	PIS1	The system can issue many rewards
	PIS2	I get a lot of rewards for reporting spam
	PIS3	If I actively report spam, I can quickly redeem the prize I want

Prototype System Construction

We constructed the mail prototype used in the experiment by creating the front end of the mail system using Vue3 and the Element Plus component library. Because the focus of this study is the token incentive mechanism, rather than the technical implementation of the email system, it does not go into technical specifics. Some of the prototype's key processes and pages are depicted below. Since the experiment was conducted in China, the original language of the system interfaces was Chinese. The text in the flowing figures was translated from Chinese using Google Translate.

When users enter the prototype, the interface will display an experiment instruction dialog, followed by a token description dialog (Figure 2) if the user is assigned to rewarded groups (group 1 and group 2).

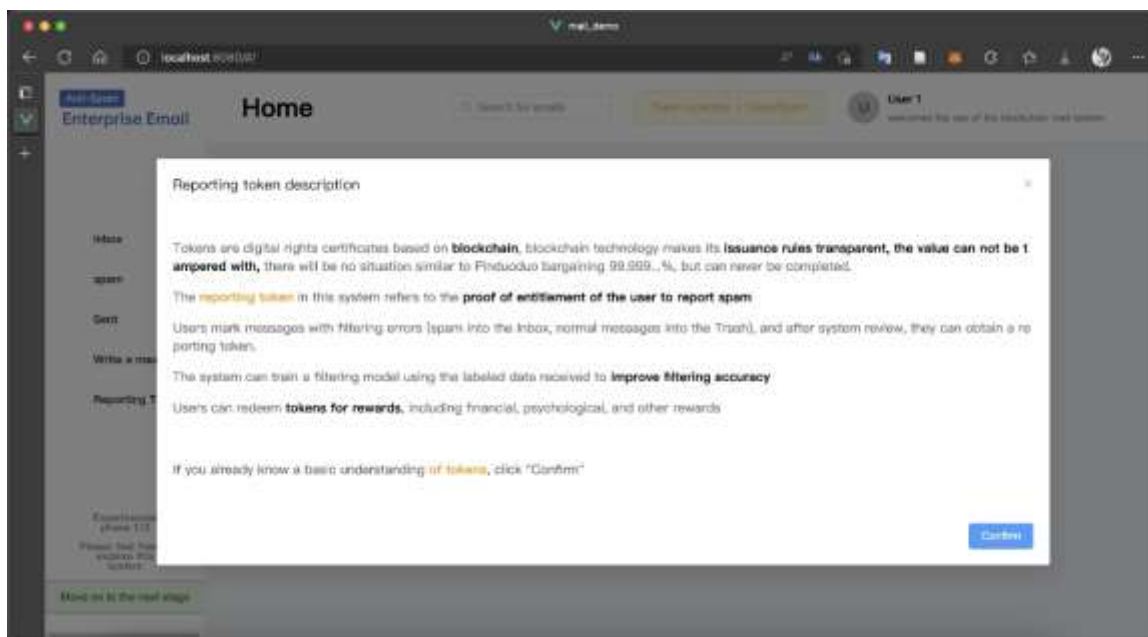


Figure 2: Token description in prototype

The main page of the prototype system contains the navigation bar on the left, the information bar on the top and the email content on the right. Users can go to the inbox, spam, sent, compose, and reporting token interfaces through the navigation bar. The information bar shows the brief information of the user and his or her token rewards. The interface of inbox is shown in Figure 3. Other pages expect for the token page are all basic functions of traditional email systems.

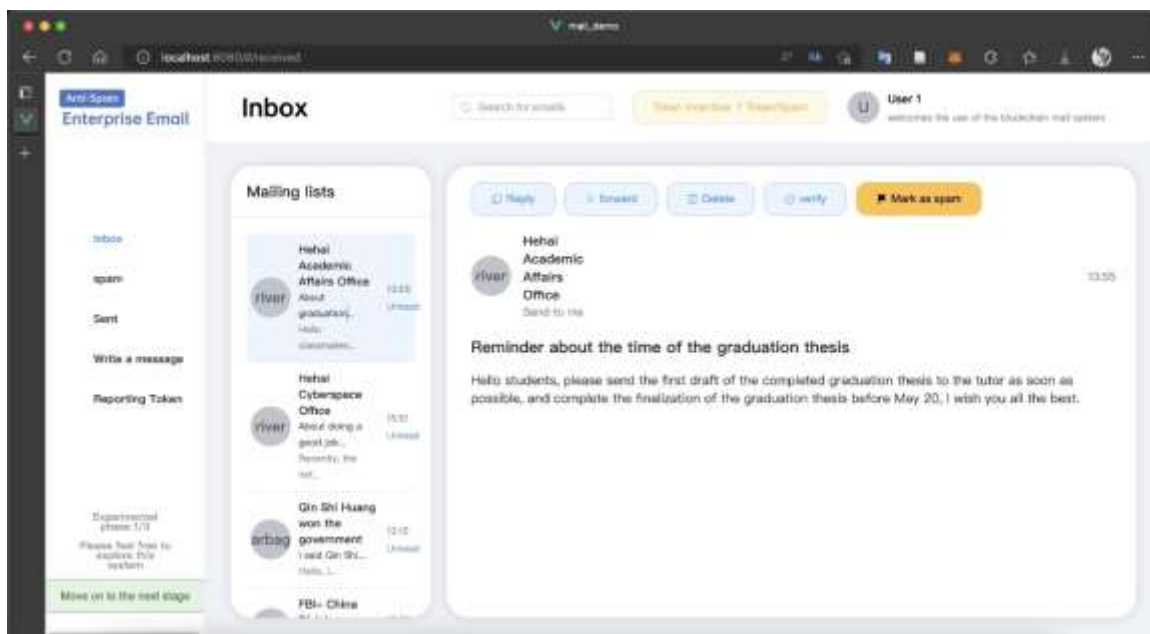


Figure 3: Inbox page in prototype

The token page for the rewarded groups is shown in Figure 4, which was not provided for the non-rewarded group. Users can use the rewarded tokens to redeem benefits in the token page, including premium service and some other specific products.

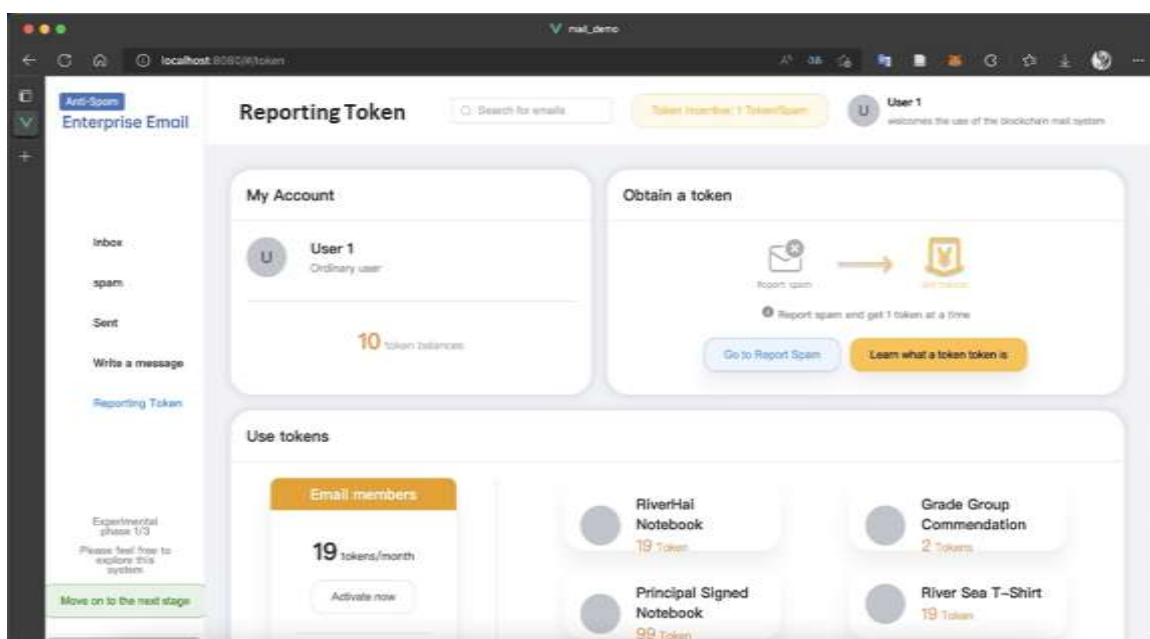


Figure 4: Token page in prototype

Implementation of Experiment

To make the experiment more rigorous, we conducted a pilot study by recruiting three experimental subjects, and then made focused adjustments on bugs and other problems discovered during the pre-experiment.

Table 3: Basic characteristics of the subject

Characteristics	Categories	Number of Participants	Proportion (%)
Sex	Male	32	64.0
	Female	18	36.0
Grade	Freshmen	6	12.0
	Sophomore	9	18.0
	Junior	16	32.0
	Senior	19	38.0

After the pilot study, 53 undergraduates participated in the formal experiment and completed the questionnaires. After removing three anomalous results, 50 valid records were obtained, with 17 in experimental group 1, 18 in experimental group 2, and 15 in experimental group 3. Table 3 shows the demographics of the experimental subjects. The distribution of participants among the three randomly assigned experimental groups was relatively balanced, and the findings of one-way ANOVA revealed no significant difference between gender and grade among the three groups.

Results and Analysis

Table 4: Results of the Experiment

Group	Incentive Quantity (Tokens/Spam)	Average Score of the Perceived Incentive Strength	Average Number of Spams Reported	Average Probability of Reporting Spam (%)
1	5	3.78	2.54	63.5
2	1	4.06	2.69	67.3
3	0	/	1.12	25.0

The experiment results for the three experimental groups with varying reward levels are shown in Table 4. The results of the two rewarded groups were significantly different from those of the control group. Specifically, one-way ANOVA revealed significant differences between groups in the quantity of spams reported ($p = 0.016 < 0.05$). In terms of absolute numbers, rewarded users in the two groups reported 2.54 incorrectly filtered emails on average, but non-rewarded users reported only 1.12 emails. In terms of probability, the probabilities of reporting for the two groups of rewarded users are higher than 60%, but just 25% for the non-rewarded users. According to the results of the experiment, the incentive mechanism increased the likelihood of users' reporting spam by more than 1.4 times. The findings reveal that the proposed design has a substantial incentive effect.

Secondly, for the two rewarded groups, the results show that the average score of perceived incentive strength was significantly correlated with the average likelihood of marking spam emails, indicating that the greater the perceived value of incentives, the more likely users were to report spam. Such results are consistent with common sense.

However, it is interesting to find that within the two reward groups (group 1 and group 2), the token reward quantity does not affect the perceived incentive strength and the reporting behavior. The results of independent-sample t-test showed no significant difference in perceived incentive strength scores ($p = 0.15 > 0.05$) and number of spams reported ($p = 0.81 > 0.05$) between group 1 and group 2.

Discussion

In the application scenario of spam reporting, the token incentive mechanism has delivered exceptional results. The increased desire to report spam by the two groups receiving token incentives demonstrates the effectiveness of the token incentive mechanism from the users' perspective.

In terms of parameters, we compared the incentive effects of 1 token/spam and 5 tokens/spam. According to the results, simply increasing the number of rewarded tokens did not make users perceive an increase in incentive strength, and the possible reasons are as follows:

(1) There is currently no incentive mechanism for reporting emails in the real world, and users feel uncertainty about how many rewards they should receive by reporting a spam mail. In other words, most users cannot create a unified cognition or standard for the quantity of incentives. For some users, 1 token/spam is already a lot, while for others, 5 tokens/spam is still rare. As a result, the perceived incentive strength varied between users in the same group, and eventually led to the insignificance of difference in perceived incentive strength scores and number of spams reported between groups.

(2) With the constraints of our experiment settings, participants could not fully reveal the value of a token through redeeming, which brought some uncertainty towards the reward strength. This phenomenon suggests that, in order to maximize the incentive effect of blockchain tokens, it is crucial to build the ecosystem for token circulation.

During the experiment, we also learned that the difficulty of explaining tokens to users may reduce the effectiveness of token incentives. It was quite difficult to quickly convey the concept of a blockchain-based token to the majority of the experiment's participants, as they were unfamiliar with blockchain technology. Negative information regarding blockchain technology, such as mining and cryptocurrency price crashes, may damage users' faith in blockchain tokens, as individuals typically resort to the technology's reputation information when confronted with novel technologies or information systems (Li et al., 2008). Therefore, when promoting and deploying blockchain tokens in the real world, it is vital to explain the concept and technical principles of blockchain tokens to users in more detail.

CONCLUSION

This research aims at designing an incentive mechanism to encourage users to report spam emails. However, there exist trust problems among the three main roles in the enterprise email system. Enterprises are concerned about the possibilities of email

data leakage, and service providers are concerned about the misuse of incentive mechanism by users and enterprises. As a result, neither the enterprise nor the service provider can serve as the central node of the incentive system. A decentralized incentive mechanism is needed to address the trust problems between corporations and service providers. Therefore, we used blockchain-based tokens to build the incentive mechanism.

In the mechanism we designed, users can get tokens rewards by reporting spam, and then use tokens to redeem other benefits from the enterprise. The enterprise obtains tokens from users and uses them to pay the service provider's service fees. The service provider pays for the costs of fee waiver but gets timely, accurate and personalized labeled spam data, which helps improve filtering performance and enhance industry competitiveness. Furthermore, the mechanism of token issuance and circulation are designed to ensure the value of tokens and that enterprises and service providers can make flexible adjustment of the incentive cost.

The results of user experiment indicated that the incentive mechanism proposed in this paper can increase the probability of users reporting spam by more than 1.4 times. Further, the ecosystem for token circulation should be well-establish so that service providers may obtain spam data at a low cost. Moreover, it is necessary to explain more clearly to users about blockchain tokens and make them trust the new technologies.

The current study still has certain limitations. First, we only employ a user experiment approach for evaluation. The incentive mechanism can be further validated from the standpoint of speculative strategy in future study. Second, we were unable to fully simulate the environment for the ecosystem of token circulation due to the constraints of the experiment, which may be better implemented in future work. Third, the results may be biased as the experimental subjects are all undergraduate students. It is feasible to enhance the experiment by recruiting enterprise email users as the subjects. And fourth, although probable explanations for the experiment results have been provided, it would be better to interpret the results from a more theoretical perspective.

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Independent station: A New Model of Cross-border E-commerce

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ABSTRACT

Currently most cross-border e-commerce sellers are engaged in cross-border e-commerce through mainstream third-party platforms. But increasingly fierce homogenization competition on third-party platforms, sharp decline of traffic dividends, constantly iterative rules and changing policies, compressed profit margins all make it more and more difficult for the sellers to secure a place in marketplace. As a result, many sellers have begun to look for new growth models and independent station is one of them. This paper introduces the overall development of China's cross-border e-commerce and background of the rise of independent station and its overall development over the last a few years. The paper explains how independent station works by making a contrast with third-party platforms, and exemplifies causes of the rise of independent station from several aspects through elaborating its benefits over that of third-party platforms and reasons why cross-border e-commerce sellers are turning to independent station. Based on the general introduction of the fundamental basics of independent station, the papers mainly elaborate the currently popular independent station operation models by explaining their characteristics, comparing their advantages and disadvantages of each of the models as well as giving examples of representative independent station companies. Since independent station is relatively a new mode of cross-border e-commerce and its development is immature thus the paper discusses some problems of independent station for the purpose of offering inspiration and enlightenment for cross-border e-commerce independent station sellers.

Keywords: Cross-border e-commerce, independent station, causes, operation models, problems.

INTRODUCTION

Despite repeated epidemic situation and complex challenges of international environment, China's foreign trades have developed rapidly. Benefiting from spillover effect of China's manufacturing capacity and comprehensive national strength China's cross-border e-commerce has maintained a high growth rate and ushered in the best period in history (E-commerce in China, 2020). In 2021, China's cross-border e-commerce import and export volume reached 1.98 trillion yuan, marking a 15% year-on-year increase. In 2022, in spite of the repeated epidemic, cross-border e-commerce has become a new battlefield for many Chinese enterprises. According to data from the General Administration of Customs, in the first five months of 2022, the total value of China's foreign trade imports and exports reached 16.04 trillion yuan, a year-on-year increase of 8.3%. Among them, exports were 8.94 trillion yuan, an year-on-year increase of 11.4%; Imports reached 7.1 trillion yuan, a year-on-year increase of 4.7%. In the light of the pandemic, it can be said that at present cross-border e-commerce development is in the golden period, and more and more Chinese enterprises have begun to develop cross-border e-commerce business (Peiyu Xu, 2022).

However, as a result of increasingly fierce homogenization competition of cross-border e-commerce third-party platforms, sharp decline of traffic dividends, constantly iterative rules and changing policies, compressed profit margins, it takes more and more time and costs for cross-border e-commerce sellers to secure a place in the marketplace, so many sellers have begun to look for new growth channels, cross-border e-commerce independent station has become one of the most popular options. A cross-border e-commerce independent station is an independent cross-border e-commerce website that has its own domain name. A cross-border e-commerce independent station supports independent modification and personalized setting of the website home page. For example, cross-border e-commerce sellers can independently design the web settings such as website theme, home page layout, banner image, product detail page, purchase interface and methods, social sharing and many other interactive features.

With independent domain names and servers or building self-operation external websites, transaction activities such as order-placing, payment, logistics, marketing are carried out within the station instead of traditional third-party shopping platforms such as Aliexpress, Amazon, eBay, just to name a few. Under independent station model sellers directly face consumers, therefore costs are reduced and transaction efficiency is improved, which is welcomed by many small and medium-sized enterprises. Using an independent station sellers can carry out more flexible network marketing, promotion in multiple channels and ways, and it is also conducive to increase traffic, improve brand impression and popularity and establish brand image. According to the 2021 Cross-border E-commerce Financial Services Report released by Ebang Think Tank, in 2021, 28.5% of cross-border e-commerce sellers built independent stations, and 8.6% of them said that the biggest sale channel was independent station (China Cross-border E-commerce Development Report, 2021).

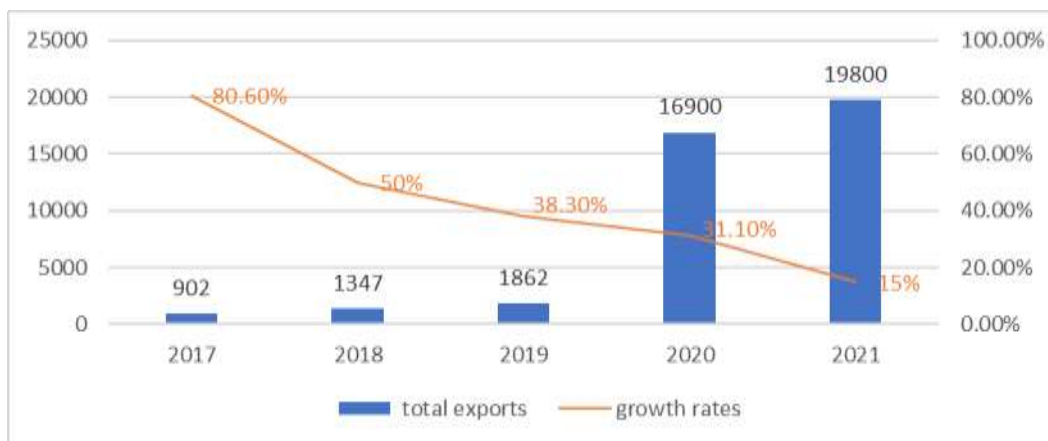


Figure 1: Cross-border E-commerce Exports From 2017-2021 in 100 million yuan
 Source: General Administration of Customs of the People’s Republic of China

CURRENT DEVELOPMENT OF INDEPENDENT STATION

Overview of Independent Station

At present, in terms of operation(operator) cross-border e-commerce platforms can be subdivided into third-party platforms and independent stations. Third-party platforms use public domain traffic as an endorsement and integrate supplying, marketing, logistics, payment, operation and other services to attract sellers to the platforms, whose profit model is mainly based on charging merchant commissions and other value-added service fees. The advantages of third-party platforms are that they have their own platform resources, sellers don’t have to worry about traffic sources; But reduction of platforms traffic dividends, intensification of homogeneous competition, constantly iterative rules and changing policies, compressed profit margins have made it difficult to secure a position in the marketplace, so transformation becomes an irreversible trend. Compared to third-party platform the advantages of independent station lie in that independent station has certain operational flexibility, for example sellers can do personalized operations and they can effectively avoid compliance risks of third-party platforms. More importantly with its own accumulation of consumer’s consumption it is easy to collect and analyze user data to operate private domain traffic, to achieve second marketing and second conversion and improve consumers’ brand loyalty and brand premium conversion rate.

In 2006 China’s cross-border e-commerce independent station market size was only about 200 billion yuan but it rose to 800 billion yuan in 2020. The total number of independent stations in 2021 reached 200,000. It is predicted that by 2025 the market share of independent station will rise to 41% from 25% in 2020. Independent station has become an important channel for cross-border e-commerce business. It is predicted that the number of independent station sellers over the next three years will exceed 500,000(China Cross-border E-commerce Development Report, 2021).

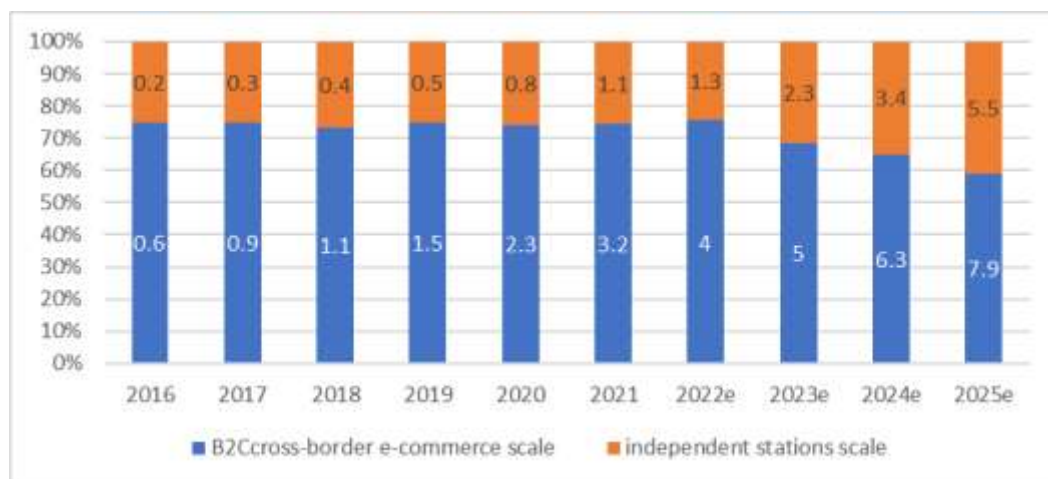


Figure 2: Other B2C cross-border e-commerce market scale VS independent station market scale from 2016 to 2025(e) in trillion yuan
 Source: Research Report on China Cross-border E-commerce Independent Station 2022

Development History of Independent Station

In early 1990s export-orientated sellers mainly relied on exhibitions for matching trade partners, however, due to language and information technology barriers there were a lot of restrictions in transactions. It was exactly the restrictions that spawned the

idea of establishing their own English websites to display seller's information demonstrate product information, but transactions were not carried out online and the websites didn't involve any transaction process, they were only used to match global partners.

Since 2002, cross-border e-commerce has gradually emerged, but there weren't many third-party platforms at that time. Platforms such as eBay and Amazon weren't strong enough then for export sellers who want to expand their overseas business, what they could only choose was independent station, surprisingly it turned out that independent station's market was even bigger than that of third-party platforms. But operating independent station was no easy thing not only because the threshold for developing website codes was very high but also involved data, information security issues, as a result early users' experience was poor. During this period, Shopify, as one of the earliest independent station construction platforms and other independent stations were on the rise.

In 2009, Shopify introduced the App Programming Pickup (API) platform and App Store. Sellers could use tools from third-party developers to further develop and customize their own online store websites. During this stage head sellers began to lay out their stores in Yama, Suncloud, Google Cloud, Alibaba Cloud and other public cloud ends. Companies such as Apple, Gucci and other brands started their own official websites and e-commerce websites. However, the engagement of small and medium-sized businesses was quite limited.

In 2016 social media platforms brought new traffic to independent station, construction of independent stations led by Shopify entered a period of rapid growth. The outbreak of the COVID-19 has led to strong online consumption, the overall operation of independent station has grown rapidly. Meanwhile competition among sellers on third-party platforms was intensifying, profits were starting to fall, besides many third-party platforms were getting more aggressive with frequent fines and unpredictable policy changes, many Amazon sellers' accounts were closed for unconscious platform policy violation.

From 2017 to 2018, the development of social media platforms entered an explosive expansion period, which helped cross-border e-commerce sellers find a new marketing path and social media platforms brought a wave of new traffic to the independent stations (Independent Website of CBEC Industry Overview, 2021).

CAUSES OF THE RISE OF INDEPENDENT STATION

Third Party Platform Policy Variation

As mentioned above public third-party cross-border e-commerce platforms such as Amazon, AliExpress, eBay, Wish, have great advantages in getting traffics for platform sellers, however, platform sellers have to pay and comply with platform rules and regulations. At the same time with increasing popularity of cross-border e-commerce and the impact of worldwide pandemic, global offline consumption is shifting to online consumption, more cross-border e-commerce sellers are attracted to mainstream platforms. As a result, mainstream platforms are becoming more and more crowded, for instance Amazon has more than 8 million sellers worldwide (Sheng Yun, 2022). Correspondingly competition is intensifying, making public domain traffic more and more expensive and difficult, platform commissions and advertising costs are also increasing significantly.

Under such circumstances it is easy for sellers to touch the bottom lines of platform rules and regulations, such as scalping, infringement, and deleting reviews, etc., resulting in platform rule variations, many sellers are received severe punishment. For example, in May 2021 Amazon issued penalties to many Chinese sellers who violated its policies, for example fine, store closure, account suspension and product removal, etc. According to data from Shenzhen Cross-border E-commerce Association, nearly 50,000 Chinese sellers have been affected, of which many were big sellers who occupy the head of the industry, and the losses generated hence have exceeded 100 billion yuan (Pengzhi Cui, 2021).

Fierce Competition

Mainstream platforms are rich in similar products and their prices are transparent, sellers are inevitably caught in price wars, compressing profit margins. To cater to overseas consumers' demands for high-quality and cheap goods, cross-border e-commerce sellers will make efforts in product selection and pricing, supplemented by necessary marketing strategies. But with the increase of sellers, platform products are likely to be homogenized, and in order to attract customers grid competition becomes the norm. If sellers want to get rid of price war, they must form differentiated competitive advantages, then high-quality products operation seems inevitable. High-quality products operation not only means product innovation, but also brand building, brand stickiness and brand premium.

Independent station helps to promote sellers' private brands to overseas costumers. First of all, the independent domain name itself has a brand promotion effect, it is convenient for overseas users to better understand sellers and their products, it can also help them feel the strength and influence of the brand, enhancing their trust in the brand; Secondly sellers and their operations are not subject to constraints of third-party platforms. Contents such as store information, products, services, and reviews can be set up in a diversified manner, what's more product key words could be rationally designed in independent stations to improve stores' search engine ranking, building brand influence and transmission. Finally, a certain brand's official website is featured with authentic and original search traffic, the growth of user group means the recognition of the brand, thus achieving full price control and gaining brand premium (Xu Lu, Jiafu Xing, and Boyuan Qiao, 2021).

Data Security Concerns

In the era of big data, cross-border e-commerce sellers need overseas users' data for the analysis of consumers' consumption behaviors, marketing strategies, products selection, promotion strategies, etc., to offer personalized products and services. But currently, cross-border e-commerce sellers are only attached to third-party platforms and cannot control and use users' data. Most of the users' data is controlled by mainstream platforms, and the data only contains industry data and platform scores, it is impossible to specifically understand overseas users' consumption behavior and shopping experience and carry out effective customer relationship management. In addition, mainstream platforms are not merely third-party intermediaries independent of platform buyers and sellers, some mainstream platforms are also actively engaged in self-operated business, they are to some extent self-operated stores who control both sellers' and buyers' data, and on the other hand they are competitors to sellers on other platforms, which also triggers sellers' concern about data security.

Instead, independent stations are self-operated websites whose transaction data can be safely obtained and controlled by independent station operators, such as traffic sources, user behaviors, characteristics, user access, page visiting time length, etc. By collecting and sorting out data analysis operators can make more accurate sales forecasting and advertising and they can also set up mailbox communication on their official website and other online interactive channels, carry out targeted market research, collect users' feedback, provide after-sales service, develop and improve the series of products and services that meet consumers' needs.

Low Entry Barriers

Building and maintaining a website is a systematic engineering project that involves website construction, front-end design, back-end support, interaction structure, SEO and other architectures. Compared to simply uploading products, receiving orders, delivering products, offering customer services, advertising and other operations on third-party platforms, building and operating an independent station require more investments in human resources, financial resources and time. Fortunately, in recent years breakthrough in SaaS (Network to Provide Software Services) technology has been made, and many open-source independent station building service platforms emerged, for example Shopify, Bigcommerce, Prestashop, OpenCart, Magento, WordPress and many others. While in China, there are Shoptago, SHOPLINE, Ueeshop, Shopyy, XShopyy, Shoplazza, AllValue, 2Cshop, etc. Those independent station building providers offer professional services to cross-border e-commerce sellers, making the entry barrier low.

From the perspective of website operation, the website building service platforms can provide interfaces with other platforms, such as third-party e-commerce platforms, third-party logistics, third-party payment systems, social media platforms, etc. What's more they still offer numerous free or paid third-party application plug-ins, involving store design, product channels, logistics channels, marketing, customer maintenance, inventory management, user behavior analysis, etc., on top of the realization of basic shopping functions, cross-border e-commerce sellers only need to install the corresponding plug-in, then more advanced functions such as EDM(email marketing), CRM(Customer Relationship Management), ERP (Internal Resource Management) will be easily realized.

INDEPENDENT STATION OPERATION MODELS

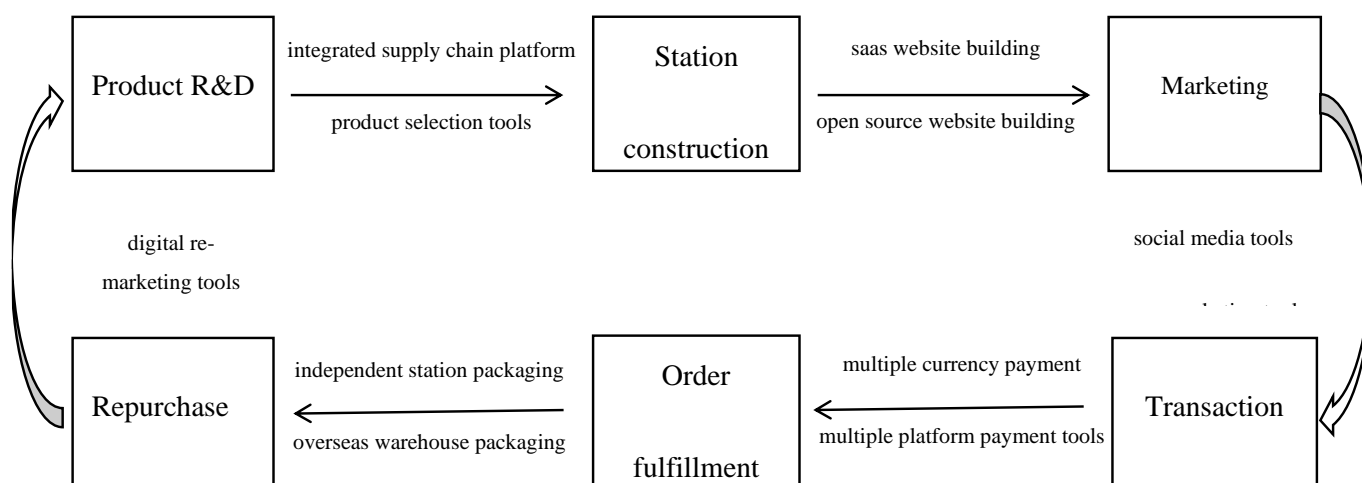


Figure 3: General operation links of independent station

General Goods Distribution

General goods distribution means uploading a large number of products onto independent stations, through which fast large-scale orders and fast sales growth could be realized shortly. Most of the early independent stations were about distributing general goods, such as Chinavasion, Deal extreme and LightInTheBox. Internet benefits and competitive prices of made in China at that time laid a good foundation for early independent station sellers. According to the division of business models of

main cross-border e-commerce platforms, independent station can be categorized into B2B or (B2W) (Business to Wholesale) distribution and B2C distribution (Yao Xiao, 2020).

B2B or B2W distribution relies on domestic manufacturing resources, distributing general products to overseas small and medium-sized enterprises or retailers. Typical representatives of B2B or B2W distribution stations include DHgate, Osell and Okorder.com, just name a few. This type of independent stations has the following features. The first is high MOQ (Minimum Order Quantity). Some websites set the minimum order at \$500 or more. The second is that independent station has high repurchase rate, since the target customers are small B-end sellers, they have a continuous procurement demand. The third is that the costs and requirements in marketing, operation and customer maintenance are relatively low compared to simple C-end users.

B2C distribution, simply could be called the distribution model B2C of independent station, targets consumer-end needs. Typical representatives include Chinaavasion, Deal extreme, LightInTheBox and dx.com. By using SEO, Google adwords and other B2C distribution channels of independent station attracted a large number of low-cost traffics and there were hundreds of thousands of SKUs on B2C platforms which means almost every product can be found. However, with rapid fading of traffic dividends in this period, and with Amazon global stores' standard product move, B2C distribution was caught in huge traffic costs, heavy supply chain and inventory pressure.

Vertical Boutique Store

Vertical boutique independent station appeared around 2010, its sellers are characterized by deep cultivation under a certain product category or a fixed industry. For example, Soufeel, a jewelry brand founded in 2009; Tidebuy, a surfer brand founded in 2010; Jollychic, a post-transformation mobile e-commerce platform found in 2012; Patpat, a mother and baby e-commerce company founded in 2014. As vertical boutique independent station focuses on vertical products in their own subdivision, the conversion rate will be higher than third-party public platforms. More importantly it is more convenient for vertical boutique segmentation station to establish a community for customer interaction which helps build good brand images. To some extent vertical boutique independent station is the mainstay of the current independent station model, and is the healthiest and the most promising.

But the problem with vertical boutique independent station is that it is difficult to obtain original traffics because it lacks trust and loyalty form a relatively niche customer group. Chances are that vertical boutique independent stations on the one hand should be deeply integrated in the supply chain. Some of the stations mentioned above have experienced gradual transition from simple imitations to original design and innovation. On the other hand, it is necessary to continuously optimize social media marketing (stations could still use SEO, email and other marketing means), and attach great importance to users' data. To achieve a steady user growth vertical boutique store could do large-scale advertising, which is an effective method to attract new customers and carry out second marketing to old customers.

COD

COD stands for Cash On Delivery, which means goods are delivered first, customers pay for the goods when they receive them to the delivery man. At present, many popular third-party logistics companies are still in this business model. Currently COD model is mainly concentrated in emerging markets such as Southeast Asia and the Middle East. Among them, Southeast Asian market is dominated by Thailand, Vietnam, Malaysia and Indonesia. COD services have a common feature, that is, the local communication network, payment methods and logistics and other basic infrastructures are relatively undeveloped. It is precisely because of these features that the cross-border e-commerce market in these regions has a strong demand for COD.

The biggest advantage of COD is that it avoids advance funds in accounting period and risks of generating bad debts. It is actually a reverse of the entire cash flow operation in which sellers' sales revenue and the cash flow are controlled by the freight forwarder. In spite of the advantages COD has bottlenecks. Data shows that about 20% of the goods delivered to customers are rejected and need to be returned to the warehouse due to various reasons. Among these returns the most common cases are discrepancies between product pictures and the actual products. This puts COD logistics companies in an awkward passive position since the logistics companies collect the payment on behalf of the sellers, as a result customers will directly return goods to logistics companies and ask for refunds rather than real sellers. What's more a large number of returns can also easily cause goods accumulation in the warehouse, causing a lot of pressure on the inventory management of logistics companies.

In viewing COD itself it caters to consumer needs in some overseas markets where online payment is immature or online payment trust base has not been fully established. In some established European countries, there is still a demand for cash on delivery. If the problems in logistics and customer service can be solved, this model may continue to be carried forward in some other markets.

DTC

DTC, abbreviation of Direct To Consumer, is a direct-to-consumer marketing model which includes any communication activities aimed at end consumers. Advantages of DTC are mainly reflected in closer relationship with consumers, more attention to consumers' consumption behavior, more attention to consumers' lifestyles.

In terms of development process of DTC, it first started from direct mail marketing (DM) which may be the most direct way to reach consumers; Then to membership marketing featuring product experience and advance consumption; And to the present accurate consumer-facing marketing to consumers relying on cross-border e-commerce independent stations. Due to strong social influence of the Internet, social media and the help of self-built independent websites, DTC greatly saves operating costs, removes middlemen and other intermediate links, and allows sellers to directly faces consumers, so DTC has greater control over consumer's personal information and consumption data (Qi Li, 2021). By using these information and data cross-border e-commerce seller could optimize their products, marketing strategies and supply chain systems in a more direct way, and gradually private traffics and customer groups are fostered.

Drop-shipping

Simply put, drop-shipping is a method of supply chain management. In its ideal state, independent station sellers are mainly engaged in attracting traffic, there is no need for them to manage inventory and shipping. Customers place orders from independent stations, then the orders are handed over to suppliers directly from factory or warehouse. After receiving the orders and customer's delivery address from independent stations, products are packaged and then sent directly to customers, customers receive the order from the supplier, and the drop-shipping process is completed.

One of the main reasons why drop-shipping is favored by many independent station sellers at home and abroad lies in its light operation. This light operation on the one hand is reflected in the fact that starting a drop-shipping project is very simple, the capital investment required is very small; On the other hand, it is reflected in the relatively small risks and high flexibility in the entire operation process. The biggest advantage of drop-shipping is the low start-up cost because you don't have inventory costs which means a fairly low risk in terms of potential financial loss. However, due to low entry barriers, drop-shipping sellers need to be prepared for a high level of competition in terms of product selection. Another shortcoming of drop-shipping is the low profit margins, perhaps the biggest drawback. Those shorting comings make it very difficult to survive in the paid advertising marketing, meaning you have to rely more on value-added services and better personalized contents in independent stations, what's more, low profit also means you have to sell a lot of goods to make a profit.

Independent Station Group

Independent station group refers to the construction of multiple websites like tens or even hundreds using station construction tools, each station has independent domain name, each station only sells vertical products within a certain industry, each station has detailed product display and company strength display, each station uses social media like Google Ads, Facebook advertising and EDM to do product testing so as to decide whether to increase SEO or and paid advertising. To put it simply, independent station group is about doing SEO through a large number of websites, putting on advertisements, testing products, creating hits, and then realizing conversion rates.

The reason for the success of station group operation lies in the linking mechanism of the search engines, which means search engines share links among themselves. Some station groups support mutual link sharing, some station groups only support one-way links. Since the aim of link sharing among search engines is about increasing relevance of target product keywords among different stations, no matter it is a mutual link sharing or one way link sharing, sharing itself ensures station relevance and content relevance, which is extremely important for search engines, because ensured station relevance and content relevance result in good SEO ranking. Another reason for the success of the station group is that search engine cannot identify all the station group models designed by experienced cross-border sellers, these models are almost no different from the real website links. In fact, the station group is a cheating method, it has been suppressed by search engines because independent station groups are not formal cross-border e-commerce stations but cheating traffics form formal stations.

Although independent station group are favored by many cross-border e-commerce sellers because it absolutely brings traffics, but they have to put in enormous time and money to its operation and maintenance. For example, the station group needs a lot of space, domain names, and in order not to be cracked down by search engines it also needs to use different IPs and VPs. What's more, building an independent station group requires each website to install a separate web program, and the daily maintenance of the website, domain name resolution, information filing and other issues all are needed to be dealt with.

INDEPENDENT STATION PROBLEMS

Uneven Operators

In recent years due to benefits that cross-border e-commerce independent stations bring, a great number of cross-border e-commerce sellers have begun to try to operate independent stations, and the surge has soared high. Many speculators have also sniffed the business opportunities, for example some have preemptively registered domain names of brands or stores that have not yet laid out in independent stations. These brands or stores often already have a certain influence and when they are going to be registered as independent stations, it turned out that relevant domain names have been registered already by speculators and they have to spend high prices to acquire them back from those speculators.

In addition to cybersquatting domain names, there are also some independent station operators who do not intend to operate a brand with long-term precipitation, they care more about short-term interests. These speculators build a large number of websites and batches of different categories of goods are listed on these websites, some of which are copycats of some high-

quality brands, and they followed in overseas media with massive promotion of these stations for the purpose of product testing. This not only causes troubles to those sellers whose brands are infringed, but also seriously harms a brand image, destroying trust of overseas customers have to Chinese products (Boling He, 2022).

Insufficient Understanding of Independent Station

Unlike traditional cross-border e-commerce platforms, the consumer conversion rate growth of independent stations is rather slow, and most cross-border e-commerce sellers are eager to see rapid growth of sales and prefer short-term high traffic returns. Lack of user experience optimization, lack of product upgrading, loose control of website data security, neglecting future developments, these are all the results of lacking of patience caused by insufficient understanding of independent stations. In addition to the lack of patience, lack of relevant experience and incomplete understanding about independent station operation models are also reasons why independent stations are difficult to succeed. For example, design of independent stations, initial budget, station promotion strategies, marketing tools and other operation issues are real problems needed to be well addressed for a large number of new entrants but their traditional business experience only work to a limited extend.

Market Uncertainties

Although independent station brings vast public domain traffic with more sources and higher conversion rates, it is difficult to obtain long-term stable high-quality traffic. The fact is that traffic sources are closely linked with the rise of social media platforms. That is to say traffic sources of independent stations are basically from major mainstream social media platforms, such as YouTube, Twitter, Facebook, Instagram, Pinterest, just to name a few. This type of traffic helps differentiated brands spread quickly in independent stations. But fast-paced online environment makes people always attracted to new contents, resulting in a marketing dilemma that is there are traffics but no sales.

The biggest advantage of the independent station is the high-quality natural traffic flow that precipitates after patient operation but the accumulation of traffic takes a lot of money and time. Promotion on different social media platforms requires a lot of funds, it can be said that the initial traffic of independent stations is through burning money on advertising. Due to unpredictable marketing effectiveness of social media platforms, and its effectiveness is difficult to evaluate, once sellers do not find high-quality traffic sources after burning rounds of money on advertising, the capital chain breaks and the station have to come to an end.

Talent Shortage

The operation of independent stations requires relevant high quality professional and compound talents. First of all, in terms of technology, construction of independent stations requires professionals who have expertise in both economics and digital knowledge. For example, when building an independent station, you need to know computer code writing to design a web page, at the same time you should also have a clear understanding of the characteristics of cross-border e-commerce sales for web page modification, optimization, maintenance and customer data analysis. In terms of operation, since cultural differences independent station originally does not have a relevant customer base and customer stickiness is weak, so it needs professional talents to push advertising and marketing so as to enhance seller's profitability, at the same time, the entire supply chain of an independent station involves product procurement, product selection, logistics management, after-sale services and many others operational matters (Jiahui Xiong, 2021). Therefore, there is a need for high quality compound talents, but the short-term development history has not been able to generate enough high-quality talents which is a real problem for many cross-border e-commerce in dependent station sellers face.

CONCLUSION

The continuous development of cross-border e-commerce has enabled Chinese manufacturing and Chinese brands to reach overseas consumers effectively, and has also provided a broader market for domestic sellers. Cross-border e-commerce is undergoing dramatic changes due to impacts of the pandemic, and one of the obvious changes is the transformation of "goods going abroad" to "brand going abroad". The construction and operation of independent station have become an important way for China's cross-border e-commerce sellers to further explore overseas markets in the fierce market competition. Known for its flexible operation, strong self-control and competitive brand-building in creating brand differentiation, independent station provides a better channel for Chinese sellers in cultivating brand and accelerating Chinese brands going abroad. Although the development of independent station has a lot of problems, yet independent station model is still the general mainstream trend of cross-border e-commerce. Cross-border e-commerce sellers should have a comprehensive understanding of independent station and should take into consideration their real condition & situation before operating an independent station so as to achieve the benefits that cross-border e-commerce independent station brings.

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Influencing factors of resident satisfaction in smart community services :

An empirical study in Chengdu

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ABSTRACT

Smart communities have shown great advantages in China's pandemic control, but also exposed the shortcomings that some smart community services (SCS) are out of touch with residents' needs in the post-pandemic era. Therefore, This study aims to explore those SCSs were needed to promote the sustainable development of smart communities. Based on the expectation disconfirmation theory and the modified ASCI model, this study establishes a smart community service resident satisfaction model and analyzes it with Amos structural equation model. The study results are as follows: (1) SCS outcome, ICT infrastructure, and SCS delivery all have a positive influence on resident satisfaction and their performances decrease in turn. (2) some of the factors that drive resident satisfaction most, such as Smart Property Service and Public Facility, have a lower rating. (3) residents are more concerned about the "cost" (including financial and emotional costs) than the quality of the SCSs. (4) Most residents' expectations of SCS are irrational and that's why it does not have a significant impact on satisfaction. (5) Resident Satisfaction is an important factor in enhancing Resident Confidence in SCS and promoting Resident Participation in improving SCS. This enlightens us that improving resident satisfaction is one of the effective ways to promote the sustainable development of Smart Community and continuously enhance the emergency response capabilities of grassroots communities in the post-pandemic era.

Keywords: Post-pandemic situation, Smart Community, Resident satisfaction, ASCI model, Expectation Disconfirmation Theory, SEM analysis.

INTRODUCTION

The outbreak of the Covid-19 pandemic has brought great impacts on human life, society, economy, politics and so on. In order to control the spread of the pandemic, countries around the world have adopted different prevention measures to control the flow and minimize large gathering of people. However, this is undoubtedly a difficult task for China, which has the second most population in the world. As the "frontline" of pandemic control, grassroots communities are bound to take territorial responsibility. They need to register the entering and leaving, monitor residents' body temperatures and do nucleic acid testing regularly, guarantee the supplies of necessary goods and medical services, etc., which place a great burden on the understaffed community work. In the meanwhile, smart community applies modern information technology to helps community workers reduce the stress, such as electronic access control, temperature measurement system, "health card" application, one-click reporting, WeChat community, "bracelet detection" for the elderly living alone, etc.

China set up the first batch of smart cities in 2013 and the first batch of smart communities in 2014. In order to guide the construction of smart communities, the Ministry of Housing and Urban-Rural Development organized the compilation and issue of the "*Guidelines for the Construction of Smart Communities (Trial)*" in 2014, which is the first top-level plan for the construction of smart communities in China. In May 2022, the Ministry of Civil Affairs and other nine departments issued the "*Opinions on Deeply Promoting the Construction of Smart Communities*", which further clarified the general requirements and development direction of smart community. With the normalization of pandemic situation, it is imperative to further improve and promote the construction of smart communities.

However, in the face of the pandemic, some problems were still exposed when communities supplies smart community services, such as ignorance of the collection of residents' actual needs, insufficient grasp of underlying needs at grassroots level, blindly pursuing back-end cloud deployment, etc. Intelligent applications are divorced from actual needs (Deng *et al.*, 2020). In the meantime, Li also pointed out that the insufficient management of intelligent tools and the lack of the platform data mining and residents' participation channels impair the potential of information technologies in communities (Li, 2020). In this regard, China's authoritative media also gave some sharp criticisms, such as "smart community is not smart, and still relies on indigenous methods in case of trouble", "the means and tools are flashy, and drop the ball at the key moments".

To this end, this paper aims at exploring what are the influential drivers of residents' satisfaction in Smart Community Services (SCS). We adopt the paradigm of mathematical empirical research. Based on the American Customer Satisfaction Index (ACSI) model, this study will select and define the main research variables and put forward research hypotheses. Then, a SCS Resident Satisfaction model will be preliminarily constructed. The data were collected through questionnaire surveys, and analyzed mainly through the Structural Equation Model (SEM) analysis. In the end, some policy implications were drawn correspondingly.

The structure of the remainder of this paper is as follows: the second section reviews the relevant articles and theories about smart community service and satisfaction. In the Section 3, we construct a conceptual model of this study based on the ACSI and present the hypothesis correspondingly. Section 4 describes the data sources, including sample selection and data collection. The process of empirical research is presented in the Section 5. Chapter 6 discusses the key findings of this paper and makes targeted policy recommendations. Chapter 7 summarizes the results of the study throughout the text.

LITERATURE REVIEW

Smart Community Service

The concept of smart community was first introduced in Silicon Valley, California, in 1993, where business leaders, community members, government officials, and educators sought to cope with the severe economic downturn and bring new life to the local community through the use of information technology. With deeper development of Smart Community, the understanding of smart community has roughly extended to not only the application of technology, but also a new governance form and value orientation.

Technology application emphasizes the use of Information and Communication Technologies (ICTs) in smart communities. For example, in *Smart Communities Guidebook*, which is developed by the California Institute for Smart Communities (1997) at San Diego State University (1997), the smart community is defined as:

a community in which government, business, and residents understand the potential of information technology, and make a conscious decision to use that technology to transform life and work in their region in significant and positive ways.

Governance form emphasizes that Smart Community reshapes the governance form of grassroots community. Jiang & Zhang believe that the smart community is a new type of community governance model, which is characterized by the fact that multiple subjects provide convenient, fast, transparent and fair public services to residents according to the actual needs of residents on the basis of integrating resources (Jiang & Zhang, 2017). Lindskog thinks that the Smart Community concept stresses the importance of collaboration, cooperation and partnership between all parties involved including public institutions, private sector, voluntary organizations, schools and citizens (Lindskog, H., 2004). Song believes that smart communities are promoting the generation of new forms of governance with the assistance of technology, which is reflected in the development of the main structure of governance from vertical to vertical and horizontal, the boundaries of governance role extend from afterwards to beforehand, and the mode of governance operation from division to co-governance (Song & Wang, 2020).

The value orientation emphasizes the ultimate value of the development of Smart Community. Shen put forward the concept of a humanistic-oriented smart community, which is the one with strong cohesion based on the collaboration and interconnection of the government, related industries and residents (Hanyan, H., 2021). Jiang believed that the value pursuit of Smart Community essentially requires us to rebuild a social community with a sense of belonging and identity (Lebrument, N., *et al.*, 2021).

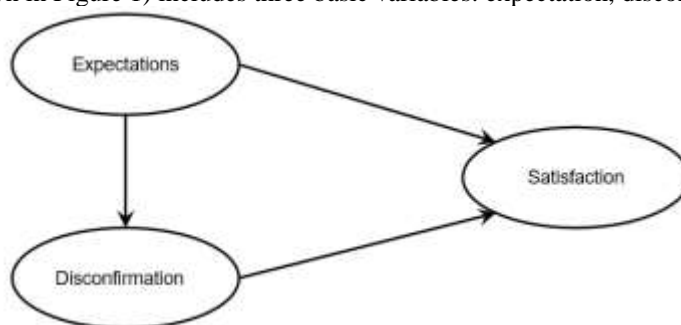
Based on the above opinions, smart community emphasizes more than technology. Residents play an important role in the development of smart community. So we think it is necessary to supply Smart Community Services with which residents are satisfied and encourage them to participate in the development of their smart communities.

As for what Smart Community Services (SCSs) contain, different scholars and institutions have expressed different views. According to the *Implementation Guide* (1997) developed by California Institute for Smart Communities, Smart Community increases choice, convenience and control for people in the community as they live, work, travel, govern, shop, educate and entertain themselves. SCIN (Smart Community International Network) thinks the smart community means to make broadband-based services delivered – such as better health care delivery, better education and training, and new business opportunities. According to *China's Guidelines for the Construction of Smart Communities*, Smart Community should have perfect infrastructures, high community governance levels, as well as the diversified community public services, and intelligent convenience services. According to Xu Li, a smart community consists of three domains: the home domain, community domain, and service domain (Li *et al.*, 2011). It can be seen that SCSs involve a wide range of issues. From the perspective of functions, it includes education, employment, pension, medical care, distribution, home, business, etc. From the perspective of providers, it covers governments, enterprises, communities and non-profit organizations. Thus, it seems necessary to know which services are the influential drivers of resident satisfaction in order to keep sustainable development of smart communities.

Expectation disconfirmation theory and models

Further, in order to clarify the influencing factors of resident satisfaction of SCSs, this paper reviews some customer satisfaction models widely used.

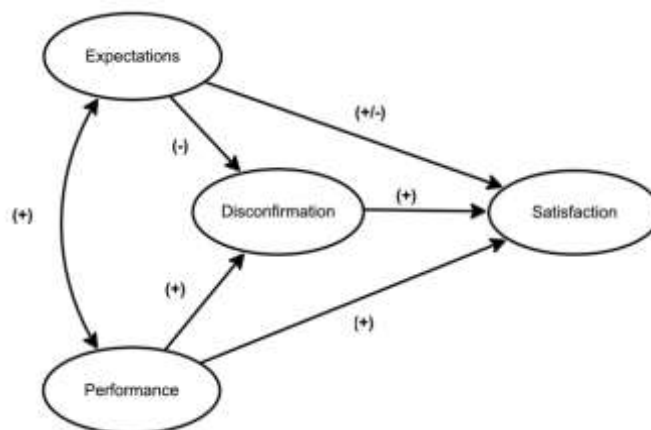
In 1965, Cardozo first introduced the concept of consumer satisfaction into marketing, and found that customer expectations are an important precursor to their satisfaction, that is, when the product don't meet expectations, consumer satisfaction is lower (Cardozo, R. N., 1965). In 1977 Oliver R. L. measured the effects of disconfirmation independent of the level of expectations, and concluded that consumer satisfaction depended on expectations and their degree of disconfirmation with actual experience. Then, he proposed the Expectation Disconfirmation Theory in his book *Satisfaction: A Consumer's Behavioral Perspective*. The theory argues that satisfaction is achieved through a two-stage process. In the first stage, customers will form "expectations" about the performance of the product before purchasing. After the customer purchases, they compare the true performance level of the consumer product with the expectations before the purchase, thus forming a gap between the two, which is called "disconfirmation". In the second stage, customers make different "satisfaction" responses in different situations of "disconfirmation": when the actual performance is the same as the expectation, that is, the "disconfirmation" is zero, the customer produces "moderate satisfaction"; When actual performance exceeds expectations, that is, "disconfirmation" are positive, resulting in "satisfaction"; When the actual performance does not meet expectations, that is, "disconfirmation" are negative, resulting in "dissatisfaction" (Oliver, R. L., 1980). Therefore, the initial expectation disconfirmation model (as shown in Figure 1) includes three basic variables: expectation, disconfirmation, and satisfaction.



Source: This study.

Figure 1: Initial "Expectation-Disconfirmation" model.

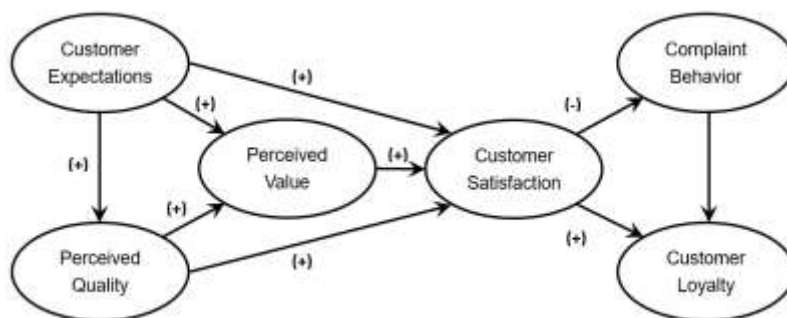
However, scholars such as Oliver R. L. ignored that the perceived product experience of the consumer also directly affects the satisfaction of consumers. Experiments by Churchill G. A. in 1982 proved, in addition to influencing consumer perceived disconfirmation, perceived performance itself has a direct impact on satisfaction, that is, when the performance of a product or service is good, customers will be satisfied, regardless of whether expectations are confirmed or not (Churchill G. A. & Surprenant, C., 1982). So he added Performance to the initial "Expectation-Disconfirmation" model to form an extended "Expectation-Disconfirmation" model (as shown in Figure 2).



Source: This study.

Figure 2: Extended "Expectation-Disconfirmation" model.

However, satisfaction is a "decision" after one choice at a time, with discontinuity. This is not enough for the organization who wants to evolve from intermittent satisfaction to continuous satisfaction, that is, Customer Loyalty. Based on this idea, in 1994, Claes Fornell, a professor at the University of Michigan and the Center for Quality Studies in the United States, who made outstanding contributions to customer satisfaction evaluation, proposed the American Customer Satisfaction Index Model (ACSI, Figure 3).



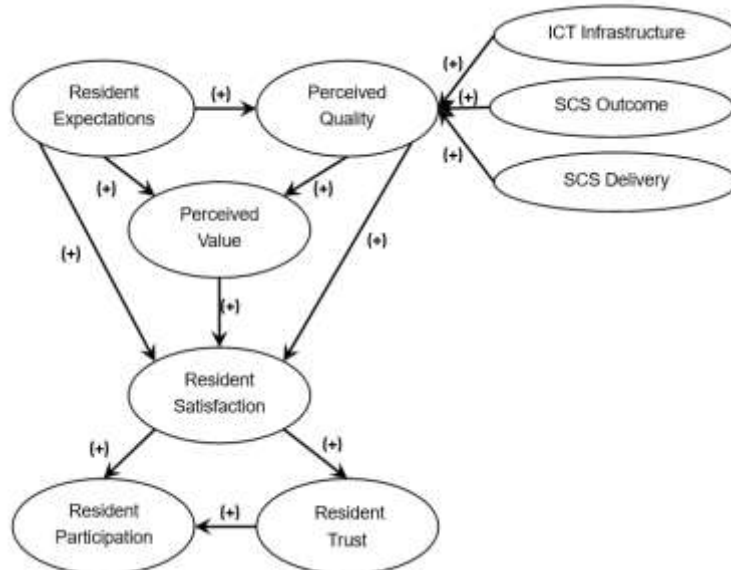
Source: This study.
 Figure 3: American Customer Satisfaction Index model.

The first researcher to introduce the concept of customer satisfaction into the community service research was the Gregg G. Van Ryzin. His School of Public Administration at city university in New York and the City Council of New York collaborated to survey the satisfaction of New York city residents with public affairs between 2000 and 2001, and the ACSI model was used in his research (Van Ryzin, G. G. *et al.*, 2004).

Throughout academia, in spite of the widely application of ACSI model, there are still insufficient research in the community service, especially Smart Community Service. Especially in Chinese institutional context, Smart Community Service has its peculiarities: Residents are not only the consumers of community services, but also providers. Community is a kind of self-governance organization, so the participation of residents in the improvement and supply of community services is an important factor. As the primary beneficiaries, residents should play a greater role in providing opinions and even in decision-making (Goodman N. *et al.*, 2020). Thus, how does Resident Satisfaction affect Resident Participation is also a question this study concerns.

CONCEPTUAL MODEL AND HYPOTHESIS

The conceptual model constructed in this article is shown in the figure 4, which includes nine potential variables. Four exogenous variables, namely Resident Expectations, ICT Infrastructure, SCS Outcome, SCS Delivery; The five endogenous variables were Perceived Quality, Perceived Value, Resident Satisfaction, Resident Trust, and Resident Participation.



Source: This study.
 Figure 4: Conceptual model.

According to ACSI model, we propose:

- Resident Expectation has a positive impact on Perceived Quality*
- Resident Expectation has a negative impact on Perceived Value*
- Perceived Quality has a positive impact on Perceived Value*
- Resident Expectation has a positive impact on Resident Satisfaction*
- Perceived Quality has a positive impact on Resident Satisfaction*
- Perceived Value has a positive impact on Resident Satisfaction*

In addition, as for the factors affecting Perceived Quality, it is undoubtful that community services include both tangible products and intangible services, so residents' perception of service quality is also affected by more diversified factors. According to the model first proposed by Christian Gronroos to measure the quality of service, he divided the quality of service into technical quality (the result of the service) and functional quality (the process of service). Based on this, this paper proposes to refine the impact factor of Perceived Quality into three dimensions: Infrastructure, Outcome and Delivery.

ICT Infrastructure has a positive impact on Perceived Quality

SCS Outcome has a positive impact on Perceived Quality

SCS Delivery has a positive impact on Perceived Quality

Trust is the outcomes of satisfaction. The relevant theoretical school in the field of marketing holds that satisfied customers will choose to buy or continue to buy products or services, and are willing to pay a premium for the product, build trust with enterprises, and form long-term and sustainable reciprocal relationships (Castaldo, S., 2009). This law may also apply to community service. Trust is a state of mind based on sustained satisfaction, and its level of abstraction is higher than satisfaction, so long-term and high satisfaction with public services is conducive to the formation of a high degree of trust (Christensen, T. *et al.*, 2005). Based on this, we propose:

Resident Satisfaction has a positive impact on Resident Trust

The influencing factors of resident participation are resident satisfaction and resident trust. When consumers have a higher level of satisfaction and trust in the brand virtual community, it is easier to favor the brand, which in turn leads to active post-purchase behaviors such as participating in the brand's product improvement activities. This paper argues that when residents have a more positive attitude (satisfaction or trust) towards smart community services, the more likely they are to develop a sense of ownership and participate in the improvement of smart community services. Based on this, we propose:

Resident Satisfaction has a positive impact on Resident Participation

Resident Trust has a positive impact on Resident Participation

Table1: the study hypothesis.

Hypothetical content	
H1	Resident Expectation has a positive impact on Perceived Quality
H2	ICT Infrastructure has a positive impact on Perceived Quality
H3	SCS Outcome has a positive impact on Perceived Quality
H4	SCS Delivery has a positive impact on Perceived Quality
H5	Resident Expectation has a positive impact on Perceived Value
H6	Perceived Quality has a positive impact on Perceived Value
H7	Resident Expectation has a positive impact on Resident Satisfaction
H8	Perceived Quality has a positive impact on Resident Satisfaction
H9	Perceived Value has a positive impact on Resident Satisfaction
H10	Resident Satisfaction has a positive impact on Resident Trust
H11	Resident Satisfaction has a positive impact on Resident Participation
H12	Resident trust has a positive impact on Resident Participation

Source: This study.

DATA COLLECTION

The Samples

Data collection was carried out within the city of Chengdu. Chengdu is the epitome of China's smart community construction process, its smart community construction began in 2013. In June 2020, Chengdu Municipal People's Government published the "*Tianfu Smart Community Construction Guidelines Version 1.0*", and in the same year selected 30 smart community construction pilot units to create 400 smart application scenarios. This provides a basis for the selection of research samples. Based on the understanding of the construction of smart communities in Chengdu, the project team selected the Hengdacheng Community in Wenjiang District, Xingrong Community in High-tech Zone, and Zhiqiang Community in Chenghua District for questionnaire distribution after conducting full field research.

Pre-investigation

Based on the Smart Community Service resident satisfaction model, this study designed a questionnaire which mainly includes two parts: the first part is the basic personal information; the second part is the measurement of the core variables involved in the study, including ICT Infrastructure, SCS Outcome, SCS Delivery, Resident Expectation, Perceived Quality, Perceived Value, Resident Satisfaction, Resident Trust and Resident Participation. These variables were measured by the Likert five-level scale.

Further, to test the quality of the questionnaire, a pre-survey was conducted, through which we can find out the problems that may occur in the implementation of the questionnaire in advance, adjust and modify the questionnaire to avoid errors in the formal survey. 20 samples were selected from each of the three investigated communities. The questionnaires were distributed face to face and 60 valid questionnaires were collected.

Based on the data collected in the pre-survey, SPSS 26 was used to test the reliability and validity of the formal questionnaire. Cronbach α for each variable is more than 0.9, indicating that the internal reliability of the scale is excellent. The KMO values are all more than 0.7, and the significance of the Bartlett's spherical degree test is less than 0.05, which passes the validity test. CITC \geq 0.5 indicates that the question setting is reasonable and all question items are retained.

Table2: Reliability and validity test results.

		CITC	Cronbach after deleting item α	Cronbach's α	KMO	AVE	CR
Resident Expectation	RE1	.833	.942	.938	.726***	0.781	0.709
	RE 2	.921	.871				
	RE 3	.865	.916				
Perceived Quality	PQ1	.914	.939	.959	.780***	0.821	0.757
	PQ 2	.907	.944				
	PQ 3	.919	.935				
ICT Infrastructure	ICT1	.873	.899	.931	.767***	0.780	0.773
	ICT 2	.873	.893				
	ICT 3	.850	.909				
SCS Outcome	OUT1	.815	.925	.935	.816***	0.542	0.571
	OUT 2	.879	.904				
	OUT 3	.856	.912				
	OUT 4	.833	.919				
SCS Delivery	DEL1	.911	.949	.961	.804***	0.777	0.767
	DEL 2	.902	.950				
	DEL 3	.900	.954				
	DEL 4	.924	.944				
Perceived Value	PV1	.900	.909	.945	.771***	0.759	0.747
	PV 2	.874	.929				
	PV 3	.885	.922				
Resident Satisfaction	RS1	.894	.918	.947	.760***	0.610	0.681
	RS 2	.859	.945				
	RS 3	.913	.903				
Resident Trust	RT1	.926	.898	.946	.733***	0.767	0.715
	RT2	.926	.898				
	RT3	.838	.977				
Resident Participation	RP1	.856	.885	.953	.759***	0.740	0.659
	RP2	.945	.897				
	RP3	.921	.901				

Source: This study.

This study compares the correlation coefficient between variables with the quadratic root of AVE value. The quadratic root of the AVE value of each variable is more significant than 0.736 and greater than the correlation coefficient between variables, so it has good aggregate validity and discriminant validity.

Table 3: Aggregate validity and discriminant validity.

	ICT	OUT	DEL	RE	PQ	PV	RS	RT	RP
ICT	0.883								
OUT	0.637	0.736							
DEL	0.362	0.594	0.881						
RE	0.305	0.604	0.301	0.883					
PQ	0.409	0.563	0.409	0.247	0.906				

PV	0.209	0.316	0.208	0.253	0.434	0.871			
RS	0.246	0.376	0.246	0.311	0.504	0.785	0.781		
RT	0.144	0.219	0.143	0.182	0.294	0.574	0.583	0.875	
RP	0.142	0.216	0.141	0.179	0.289	0.566	0.574	0.658	0.860

Source: This study.

Formal Investigation

The formal investigation was conducted from 5 March 2021 to 11 April 2021. The final questionnaire was distributed offline mainly with the help of community workers in spite that their presence may have an influence on the survey results. Finally, 342 valid questionnaires were collected, and the effective recovery rate was 91.9%.

Table 4: Issuance and recovery of formal questionnaires.

Community	Number of questionnaires distributed	Number of recycled questionnaires	The number of valid questionnaires	Effective recovery rate
HengDaCheng Community	129	129	119	92.2%
XingRong Community	116	116	102	87.9%
ZhiQiang Community	127	127	121	95.2%
total	372	372	342	91.9%

Source: This study.

RESULT

Descriptive Statistics

The following table lists some variables for basic characteristics of the samples. Among them, men accounted for 38% while women accounted for 62%. The proportion was not balanced, which is related to the fact that women are more socially involved and more willing to cooperate with our questionnaire. And we can also see that more than 90% of the respondents had lived 2 years or above, which ensures their contact with the community. The distribution of other variables is also in line with objective reality and the sample is representative to a certain extent.

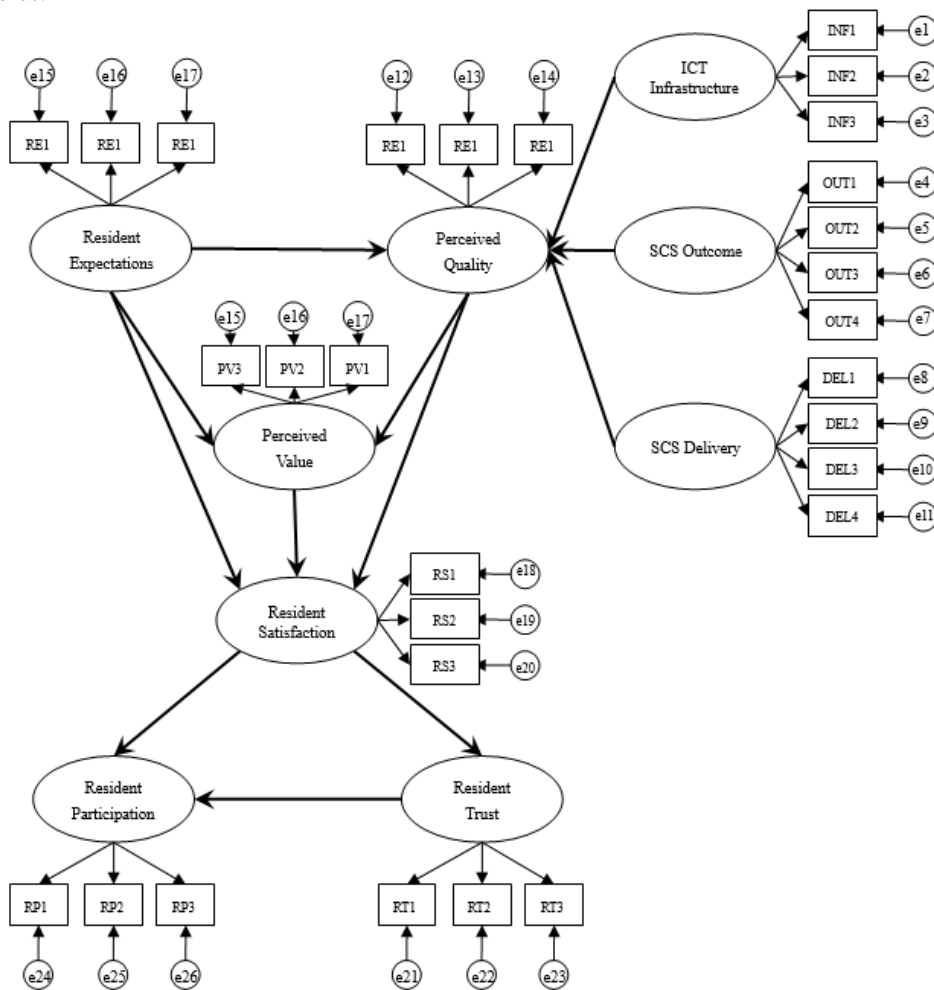
Table 5: the characteristics of the samples.

Variables	Frequency	Percentage (%)	
Gender	man	130	38.0
	woman	212	62.0
Age	≤20	26	7.6
	20~40	190	55.6
	40~60	95	27.8
	>60	31	9.1
Job	Public officials	71	20.7
	Corporate employees	88	25.7
	Self-employed	51	14.9
	Farmers	13	3.8
	Students	32	9.4
	Departing or retiring	59	17.3
	other	28	8.2
Education	High school and below	102	29.8
	College	96	28.1
	Bachelor	129	37.7
	Master and above	15	4.4
Living Duration	Less than 1year	31	9.1
	2-5 years	111	32.5
	6-10 years	93	27.2
	11years and above	107	31.3

Source: This study.

Structural Equation Analysis

To further clarify the influence of different variables, this paper used SEM for analysis. First, the following model is drawn in AMOS24 (Figure 2), which contains 9 latent variables (including 4 exogenous variables and 5 endogenous variables) and 26 observational variables.



Source: This study.

Figure5: structural equation model of resident satisfaction in smart community services.

Model fitting

First, we need to evaluate whether the above initial model holds. Structural equation model evaluation is divided into three parts: measurement model evaluation, structural model evaluation, and model fit evaluation, which are judged by factor loading, path coefficient, and fitting index, respectively. This study applied four fitting index: RMSEA, GFI, NNFI, and CFI, which are not affected by the sample size, punish complex models and sensitive to misdesigned models (Marsh, H. W. & Balla, J., 1994). The evaluation results of the initial structural equation model are shown in Tables 6, 7, and 8.

It can be seen from Table 6 that only three of the fitted values of the initial model have reached the criteria. From Table 7, the factor loading coefficients of each variable are greater than 0.5, indicating that each observation variable is of statistical significance and can well reflect the corresponding potential variables. From Table 8, it can be seen that three paths do not pass the statistical test at a confidence level of 90%, indicating that there is still room for optimization of the model.

Table 6: Fitting test results.

Index Name		Fitting value of this model	Critical value	Recommend value
Absolute fitting index (Overall Fitting Index)	GFI	0.832	> 0.9	> 0.8
	RMSEA	0.084	< 0.05	< 0.08
Relative fitting index (Delta Fitting Index)	CFI	0.892	> 0.9	> 0.8
	NNFI	0.878	> 0.9	> 0.8

Source: This study.

Table 7: Model factor loading results.

		Estimate
Resident Expectation	RE1	.869
	RE 2	.916
	RE 3	.866
Perceived Quality	PQ1	.915
	PQ 2	.900
	PQ 3	.903
ICT Infrastructure	ICT1	.878
	ICT 2	.896
	ICT 3	.875
SCS Outcome	OUT1	.740
	OUT 2	.763
	OUT 3	.725
	OUT 4	.715
SCS Delivery	DEL1	.839
	DEL 2	.920
	DEL 3	.884
	DEL 4	.880
Perceived Value	PV1	.886
	PV 2	.886
	PV 3	.841
Resident Satisfaction	RS1	.694
	RS 2	.750
	RS 3	.887
Resident Trust	RT1	.864
	RT2	.883
	RT3	.881
Resident Participation	RP1	.853
	RP2	.869
	RP3	.859

Source: This study.

Table 8: Standardized path coefficient estimation results.

	Estimate	P
Perceived Quality←Resident Expectation	-.191	.190
Perceived Quality←ICT Infrastructure	.098	.001
Perceived Quality←SCS Outcome	.911	***
Perceived Quality←SCS Delivery	.031	.005
Perceive Value←Resident Expectation	.192	.251
Perceive Value←Perceived Quality	.391	***
Resident Satisfaction←Resident Expectation	.087	.670
Resident Satisfaction←Perceived Quality	.097	***
Resident Satisfaction←Perceive Value	.589	***
Resident Trust←Resident Satisfaction	.799	***
Resident Participation←Resident Trust	.432	***
Resident Participation←Resident Satisfaction	.398	***

Source: This study.

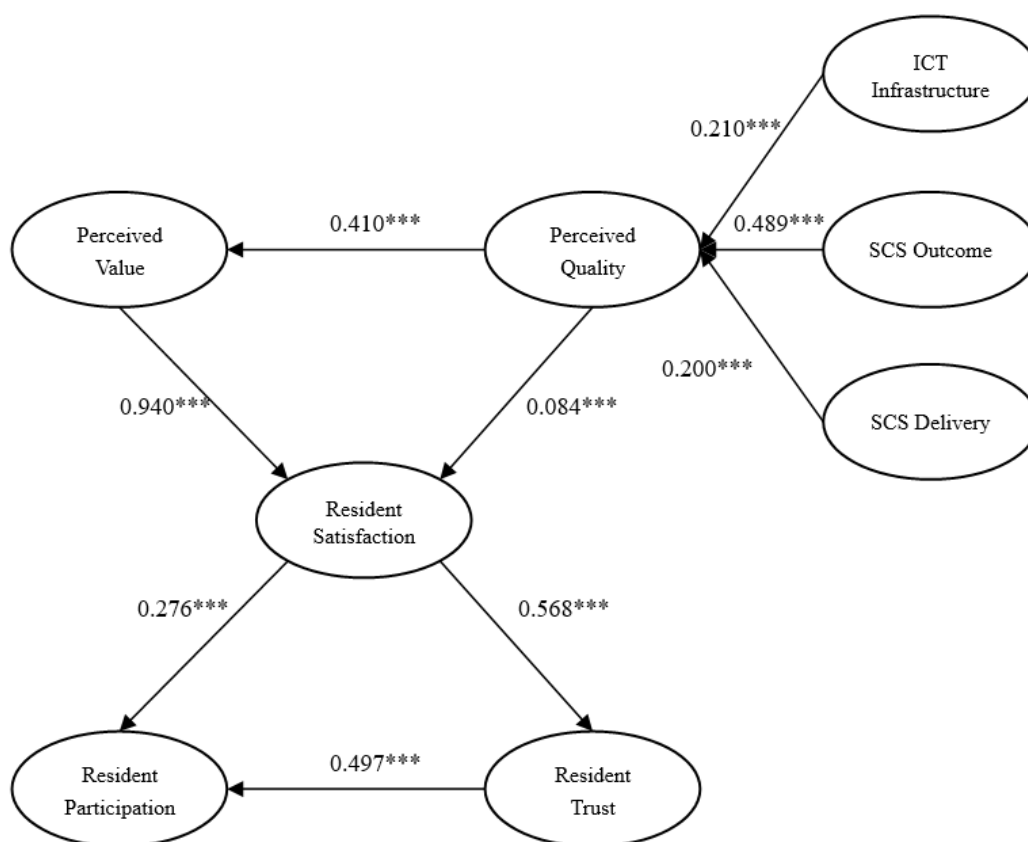
Model modification

The correction of structural equation models generally adopts two methods, model extension and model limitation. Model restriction refers to deleting insignificant paths in the initial model, or restricting some paths to make the model more clear. There is a path in this study that is not significant, so the "resident expectations - perceived quality", "resident expectations - perceived value", "resident expectations – resident satisfaction" paths are deleted in the model correction. After the correction, the fitting index of the model tends to be better, and the standardized path coefficient of the model is significant, so the modified model is accepted as the final model (as shown in the figure 6).

Table 9: Corrected fitting test results.

Index Name		Fitting value of this model	Critical value	Recommend value
Absolute fitting index (Overall Fitting Index)	GFI	0.847	> 0.9	> 0.8
	RMSEA	0.071	< 0.05	< 0.08
Relative fitting index (Delta Fitting Index)	CFI	0.913	> 0.9	> 0.8
	NNFI	0.923	> 0.9	> 0.8

Source: This study.



Source: This study.

Figure 6: simulation path coefficient diagram.

According to the analysis results of the structural equation model, the influencing factors and influencing mechanisms of resident satisfaction with SCSs are studied. According to the results of the SEM analysis, H1, H5, H7 did not pass the test, and the results obtained are shown in the table:

Table 10: Hypothesis test results

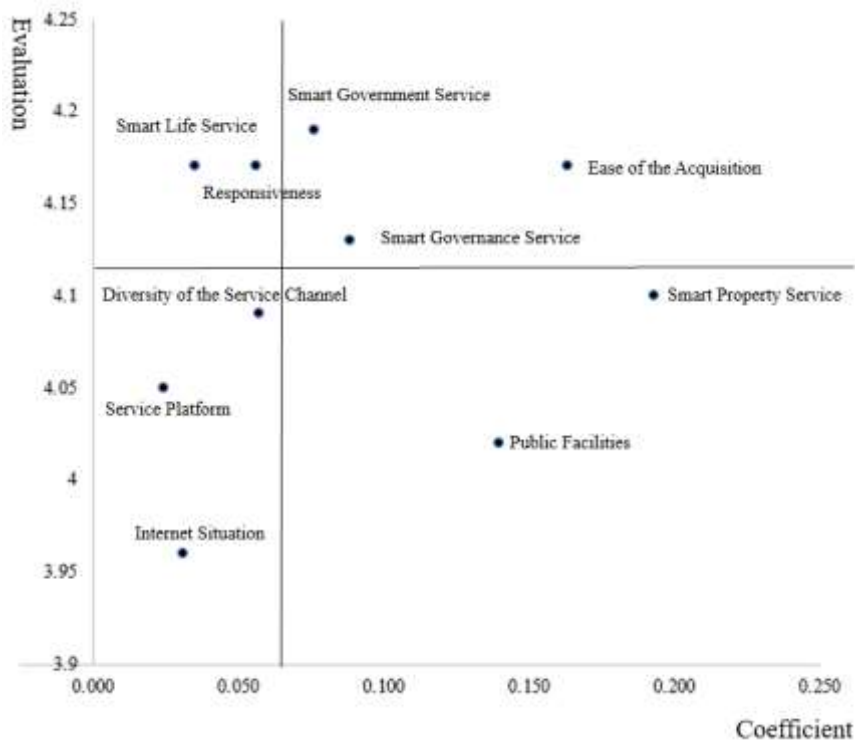
	Hypothetical content	Result
H1	Resident Expectation has a positive impact on Perceived Quality	Refused
H2	ICT Infrastructure has a positive impact on Perceived Quality	Accepted
H3	SCS Outcome has a positive impact on Perceived Quality	Accepted
H4	SCS Delivery has a positive impact on Perceived Quality	Accepted
H5	Resident Expectation has a positive impact on Perceived Value	Refused

H6	Perceived Quality has a positive impact on Perceived Value	Accepted
H7	Resident Expectation has a positive impact on Resident Satisfaction	Refused
H8	Perceived Quality has a positive impact on Resident Satisfaction	Accepted
H9	Perceived Value has a positive impact on Resident Satisfaction	Accepted
H10	Resident Satisfaction has a positive impact on Resident Trust	Accepted
H11	Resident Satisfaction has a positive impact on Resident Participation	Accepted
H12	Resident trust has a positive impact on Resident Participation	Accepted

Source: This study.

Linear regression analysis

In order to further understand the performance of specific SCSs on Resident Satisfaction, a simple linear regression analysis was conducted. The independent variables include 11 indicators, which are the observed variables of ICT Infrastructure, SCS Outcome and SCS Delivery, and the dependent variable is the overall satisfaction of residents, which is the observed variables of Resident Satisfaction. Except for the variable "clarity of the service platform function", the remaining variables have a significant impact on the overall satisfaction of the residents at a confidence level of 90%. Further, we take the resident evaluation of these SCSs as the ordinate coordinate, and the coefficient as the abscissa coordinate to draw the figure below. The horizontal and vertical lines in the figure respectively represent the average level of resident evaluation and the average level of coefficient. The overall level of resident evaluation is seemingly very high, which may be related to the community workers' presence in the survey and the residents' tendency to have a good social evaluation. As we can see in the figure 7, the Network Situation is rated lowest, while Smart Government Service highest. Smart Property Service has the greatest impact on the overall satisfaction, and the Service Platform has the smallest impact. It is worth noting that Smart Property Service and Public Facilities have a greater impact on overall satisfaction, but they have not shown high evaluations. To a certain extent, the results show some shortcomings of SCSs.



Source: This study.

Figure 7: Specific SCSs performance

DISCUSSION

Empirical results discussion

The explanation of the empirical findings in this paper will be supplemented by interviews. Interviews and questionnaires were conducted at the same time, thus ensuring consistency of sample sources. Interviews are conducted in a semi-structured manner. Subject to anonymity and consent of the interviewee, the interview is recorded and transcribed to text. In the end, 52 interview records were obtained, and the duration of the interviews ranged from 21 mins to 42 mins. With the help of NVivo software, 203 valid interview statements were transcribed, encoded and analyzed using the thematic analysis technique.

Resident Expectation has no significant impact on Resident Satisfaction

Resident Expectation has a bad performance in the study model. Some similar results have also been seen at Johnson and Martensen's paper (Johnson, M. D. *et al.*, 2001; Martensen, A. *et al.*, 2000). This study argues that this conclusion reflects the lack of sufficient experience and awareness of residents to use SCSs to form rational expectations. This can be caused by the following three reasons:

First, SCSs are not mature, still in the pilot exploration stage. It takes a certain amount of time to make residents gradually contact with SCSs and have a basic understanding of them. And due to the difficulty to build a basic technical framework in these communities, especially those old communities, the existing SCSs that are in direct contact with residents are relatively scattered. Therefore, residents' perception of SCSs is not obvious, and it is impossible to form accurate and rational expectations for them. During our research, staff from different communities gave us feedback:

This work (the construction of Smart Community) was promoted in 2019, and then in 2020, various communities also began gradually. Thus, the SCSs' coverage of the population is not very extensive.

What we've done is slowly implanting these services, and it will definitely take time for residents to understand.

At present, our community supplies mainly smart security service, and other application scenarios are considered to add in constantly. Some negotiations need to be conducted step by step.

Second, the supply and demand of SCSs are misaligned. Most of the construction of smart communities in China is promoted by grassroots government, rather than residents themselves. Therefore, there may be a lack of awareness of the residents' needs in the construction process. At the same time, the heterogeneity of urban community residents means that they have more personalized demand for SCSs. For example, the elderly may have certain difficulties in technology acceptance so that a "age-appropriate" transformation of SCSs may be needed. This phenomenon can be reflected by feedback as follows:

The financial funds or the investment must be first used in the most basic and important part (eg. network). For the related services of the smart community you mentioned, the residents' possible feelings are not so strong and obvious.

There may be only more than a dozen households who has used the VR Planning Pavilion project. So for a resident who hasn't experienced the program, he probably doesn't have a perception of the effect that technology or smart community brings to residents.

How do residents know what your smart community is, for ordinary residents, especially for the elderly, he does not understand much and maybe does not believe it, right? So I think the problem of the operation needs to be considered.

Third, the "attractiveness" of SCSs is insufficient. The obvious change brought about by the market-oriented reform is the transfer of community functions to the entire city area. Many residents are not "customer sticky" to community service, and they are more inclined to seek the services they need across the city. Due to the limitations of subjective and objective conditions such as funds and resources, community services are less competitive than market services, so the residents do not have too many expectations for community services. As a resident said: *Many young people are actually not very willing to participate in the community as the elderly.*

But at the same time, we also see the potential of SCSs to "bring residents back to the community". Residents, especially young people, may be willing to use SCSs out of curiosity.

Because young people are used to contacting with others online rather than offline, some community activity information will be released through WeChat groups in order to promote their participation.

Perceived Quality is mainly affected by SCS Outcomes, and the impact of ICT Infrastructure and SCS Delivery is smaller

Of the three factors that significantly affect the Perceived Quality, SCS Outcomes interpreted it to a degree of 48.9%, while ICT Infrastructure and SCS Delivery only 20%. This reveals that the three factors are all the drivers of Resident Satisfaction. Specifically, there are some SCSs which have greater impact on the overall satisfaction but lower evaluation of the residents. This result reveals the shortcoming that some SCSs have not met the resident's needs, which we should pay more attention to them.

Perceived value rather than perceived quality affects Resident Satisfaction

In addition, "Perceived Quality" interpreted Resident Satisfaction to a degree of 47% (including direct effects and mediating effects), while "Perceived Value" 94%. Comparing the explanatory power of perceived quality and perceived value, it can be found that Resident Satisfaction is not only affected by the quality of the SCSs, but also by residents' perception of SCSs costs. In other words, SCSs with high "cost performance" are more likely to be recognized by residents. Resident Satisfaction will be significantly enhanced if they can obtain quality services with less cost, less effort, and less risk. This enlightens us to consider the "profits" and "losses" of residents in the supply of SCSs, and try to avoid flashy SCSs.

Resident Satisfaction has a significant impact on both Resident Trust and Resident Participation

From the analysis results of the structural equation model, it can be seen that Resident Satisfaction can explain Resident Participation at the level of 56%, and the explanatory level of Resident Trust is 50%, which are consistent with the hypothesis of this paper. The enlightenment of this conclusion is that, by improving resident satisfaction and thus building a kind of trust relationship, a wider range of residents will be attracted to use and participate in the promotion of SCSs, which is conducive to the penetration of SCSs. In the long run, the establishment of the "satisfaction-trust-participation" mechanism is beneficial to achieve benign circle of SCSs development.

Countermeasure and suggestions

Strengthen the publicity of Smart Community Service

The impact of Resident Expectation on Perceived Quality is not obvious, which means that residents lack sufficient knowledge and experience of the actual performance of SCSs, so it is difficult to reasonably predict. Therefore, it is particularly important to stimulate the demand for public services through publicity and guidance (Zhang & Li, 2017). First of all, design a characteristic smart application scenario to draw a beautiful picture of the smart community for the residents and improve the residents' awareness of the smart service. Second, for residents with different demographic characteristics and different needs, guide them to pay attention to and use relevant smart projects to stimulate residents' demand for SCSs. Finally, through various training and education methods, the digital skills and operational proficiency of residents will be improved, and the feasibility of residents using SCSs will be improved. Through the above three points, we will promote the use and penetration of SCSs among all residents, and lay a certain "user foundation" for the development of smart communities.

Provide those SCSs that meet the needs of residents

The driving force and source of the development of smart communities should come from the needs of residents. If it is divorced from the needs of residents, the construction of smart communities may lose its direction, and it is difficult to obtain accurate feedback from residents, which is not conducive to the sustainable supply and further improvement of SCSs. Therefore, the smart community service supply abandons the "top-down" design idea and returns to the "bottom-up" life standard (Wang, 2020). Although the policies, funds and other resources required for the construction of smart communities are inseparable from the support of the government and market enterprises, this does not mean that the construction of smart communities should be planned and constructed according to their wishes. On the contrary, the frontline workers and residents of the community are the people who truly understand the life situation of the community, and they are the main participants and decision-makers in the construction of smart communities, not just the role of policy implementers. The design of smart service projects should fully consider the different types of communities and the differences in the composition of community residents, based on the characteristics of the community itself, coordinate the allocation of relevant resources, and design applicable and practical smart service scenarios. When planning smart community service projects, community workers should base themselves on long-term development goals, pay attention to the evolution catalysis of the community itself, internal functions and external functions, create sustainable development of smart service projects, and respond to heterogeneous and changeable residents' needs.

Integrate online and offline SCSs

The result that the service process has a small impact on the perceived quality enlightens us that the construction of smart communities not only needs to improve the online service platform, but also pays attention to the emotional experience of residents in the process of manual service. The construction of smart communities is not only a technical issue, but also a matter of system and mechanism. Only by fully coordinating technical elements and institutional elements can we form a high-quality smart community service system. This article believes that we can start from the following two aspects:

First, mobilize offline resources to support online platforms. Our survey found that the functions of the community's smart service platform are mainly based on community information publicity, community activity release, etc., and the coverage is narrow, and many residents have practical needs of the services that are not integrated into the platform. The integration of these services must first open up the system and mechanism of cooperation, and then supplemented by corresponding technical means, in order to promote information sharing and business collaboration between the community and other entities, and help the realization of the goal of "one-stop service".

Second, online services have "landed" to benefit residents. Another key point in the integration of online and offline services is to effectively solve the needs of online residents offline. In our survey, we found that many online service platforms such as public accounts, mini programs, and APPS in many smart communities have different degrees of "zombie websites", and these platforms have become "decorations" and "facades". The solution to this problem comes down to improving the institutional system that is compatible with the operation of the platform. Subjectively raise the service awareness of community workers, grassroots governments and other relevant parties through specific incentives; Objectively, the necessary supervision and retrospective procedures can be set up to assess the effectiveness of the service.

Based on residents' satisfaction and residents' trust, guide residents to participate in the improvement of SCSs

The word "smart" in the smart community highlights the importance of human participation more (Dutta-Bergman, M. J., 2005). Objectively speaking, the construction of smart communities in China is still in the initial exploration stage, and it is indispensable to mobilize residents to participate in the improvement of the smart service system. Therefore, on the basis of

stimulating residents' demand for SCSs, let residents see the broad prospects of smart services, in order to improve residents' motivation to participate. From the perspective of the "satisfaction-participation" path, it is necessary to give residents a convenient feedback and supervision channel to empower residents to continue to participate in the improvement of SCSs. From the perspective of the path of "satisfaction-trust-participation", residents have a strong relationship with the community, so it is necessary to play the "emotional card" well, stimulate the residents' sense of ownership and then make them actively participate in the improvement of SCSs.

As far as the former is concerned, the good interaction between the service provider and the demand side of the smart community is its inherent attribute. Communities should use modern information technology to improve the construction of such interactive platforms, so that information is interconnected, increasing the source of information access and reducing the difficulty of access, thereby lowering the threshold for residents' participation and promoting more residents to participate in community affairs (Matei, S. *et al.*, 2001). At the same time, with the help of the characteristics of virtual communities, the "strangeness" between residents is eliminated, and the group dynamic mechanism is shaped to promote the activity of residents (Rheingold, 1993), so as to establish a community of mutual care, mutual help, equal exchanges, and democratic consultation in the community (Jiang, 2017).

In the case of the latter, communities need to focus on raising the temperature of smart services. By highlighting the concept of fair and open service in specific services, paying attention to the "key masses", providing personalized smart services, and creating smart services with community characteristics to enhance residents' sense of community, the value orientation of "people-oriented" is highlighted in the whole process of smart services, and then the motivation of residents to participate is activated.

CONCLUSION

Conclusions of the study

In this paper, a resident satisfaction in SCSs model is constructed based on the theory of "expectation inconsistency", and then an empirical study is carried out through SEM analysis. The following research conclusions are drawn:

(1) SCS outcome, ICT infrastructure, and SCS delivery all have a positive influence on resident satisfaction and their performances decrease in turn. (2) some of the factors that drive resident satisfaction most, such as Smart Property Service and Public Facility, have a lower rating. (3) residents are more concerned about the "cost" (including financial and emotional costs) than the quality of the SCSs. (4) Most residents' expectations of SCS are irrational and that's why it does not have a significant impact on satisfaction. (5) Resident Satisfaction is an important factor in enhancing Resident Confidence in SCS and promoting Resident Participation in improving SCS.

Research Significance and Prospects

This paper has the following research significance: First, based on relevant literature research, combined with the characteristics of SCSs, based on the theoretical model of expectation inconsistency, a model of satisfaction of smart community service residents is constructed, and the empirical paradigm under the issue of smart community is enriched. Second, some of the theoretical findings of this study form a theoretical dialogue with existing research to deepen the understanding of the direction and nature of smart community service. Third, the research results of this study reveal some existing phenomena in the process of smart community construction, and based on the discussion and analysis of the causes of the phenomenon, put forward policy suggestions such as focusing on the publicity of SCSs, paying attention to matching service content with residents' needs, focusing on the integration of online and offline services, and focusing on guiding residents to participate in the improvement of SCSs based on satisfaction and trust, responding to the dilemma of smart community development and providing reference for the practice of smart community construction.

Admittedly, there are some obvious shortcomings in this study: this study takes the form of questionnaires to collect cross-sectional data, and we inevitably doubt whether residents already have clear expectations before receiving services, so there may be endogenous problems between the variables of expectation, quality perception and satisfaction, and further experimental research methods are needed to eliminate the influence of confounding factors and obtain more convincing causal relationships. In addition, due to the resource limitations of the researchers, this study only selected three community residents as samples within the scope of Chengdu City, and obtained 342 valid questionnaires, and there is still room for optimization in the expansion of the sample size.

The outbreak of covid-19 may have created opportunities for the development of the digital society, and the construction of smart communities has become a very valuable topic facing experts in contemporary academic and practical circles. However, as Scott Charleed puts it, "technical complexity is accompanied by the complexity of the organizational structure and the complexity of the performer". How to form a synergy between government departments, between governments and enterprises, and communities, and provide SCSs that make residents more satisfied, will become a problem that we need to further explore.

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Is online learning still necessary after the pandemic? A study of students' opinions towards factors affecting learning

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ABSTRACT

When the COVID-19 pandemic began to unravel, educational institutions in Thailand returned to teaching onsite or face-to-face. Both teachers and students had to once again adjust themselves to teaching and learning in the new normal way. However, some students still require online and hybrid learning. This research aims to study factors affecting students' preferences for the three learning formats, which are 1) 100% onsite, 2) 100% online, and 3) hybrid learning. We collected data from 158 undergraduate students in one university in Thailand. The analysis results indicate that students who prefer 100% onsite learning value interactions with their instructors and friends. This group of students feels they cannot concentrate or understand the content when studying online. On the other hand, students who prefer 100% online learning think that travelling to campus wastes time and money. They feel that they can concentrate well when studying online. Also, they believe in online evaluation systems such as online exams. Lastly, students who prefer hybrid learning like to review the courses by watching class recording videos, especially those on theoretical subjects. Moreover, they feel that the faculty and university are ready for hybrid learning in terms of the equipment, tools, and Internet connections.

Keywords: Onsite Learning, Online Learning, Hybrid Learning.

INTRODUCTION

During the outbreak of COVID, similar to other types of organizations, educational institutions had to find an approach to continue doing their business. Educational institutions, including schools and universities, must teach 100% online. Both teachers and students had to adapt to the online environment by learning and using all the programs and tools to make online teaching and learning as efficient and effective as possible. For almost two years, teachers and students have been familiar with online education.

After the COVID-19 pandemic began to unravel, some schools and universities in Thailand started their hybrid learning or a mix of onsite and online education. In May 2022, all schools and universities reopened and began teaching and learning 100% onsite. Teachers and students once again had to adjust themselves back to the traditional classroom environment. Chulalongkorn University, Thailand, also announced its 100% onsite education policy at the beginning of the academic year 2022 or in August 2022.

However, after almost two years of online education, students may have different opinions about learning formats due to many factors. Some students are satisfied with studying online, some are eager to come to university to mingle with teachers and friends in onsite learning, and some may enjoy the flexibility of the hybrid learning system.

This research aims to find the answer to whether online learning is still necessary after the pandemic by studying factors affecting students' preferences for the three learning formats, which are 1) 100% onsite, 2) 100% online, and 3) hybrid learning. The factors of interest include 1) students' personal opinions, 2) students' attitudes toward online learning, 3) students' attitudes toward instructors, 4) students' attitudes toward courses, and 5) students' perceptions of faculty and university readiness. Findings from this research will help teachers and educational institutions better understand their students and ultimately provide them with the most suitable learning formats to obtain more efficient and effective outcomes.

LITERATURE REVIEW

Onsite, Online, and Hybrid Learning

Because of the COVID-19 pandemic, people worldwide must adapt to the new normal way of living, including how we educate our students. Luckily, with the advancement of information technologies, networked technologies, and wireless

connections, teachers and students can interact beyond the traditional classroom environment, or “onsite” learning, via electronic learning, or so-called “online” learning. Instructors can take advantage of online learning to meet the needs of students at all levels of education, especially when the pandemic conditions do not allow students to learn in traditional onsite settings (Teo et al., 2014). Moreover, to take good attributes from both “onsite” and “online” learning, there comes the “hybrid” learning or a mix of onsite and online education.

Research on Online Learning in Thailand

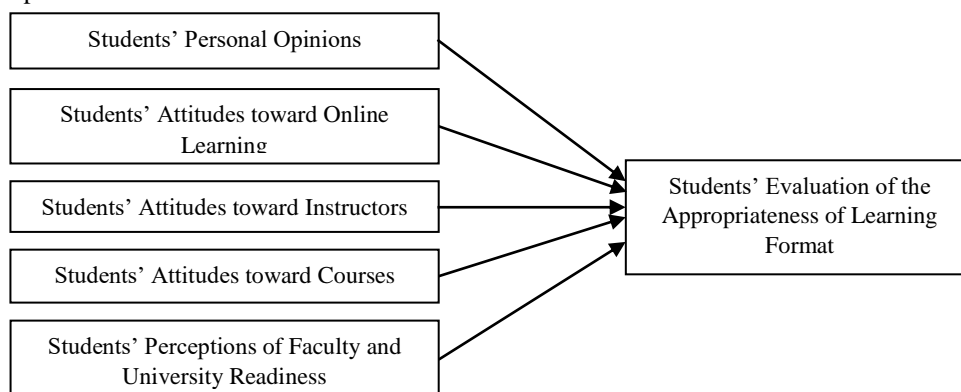
There are many studies concerning online learning in Thailand (Teo et al., 2014; Olivier, 2017; Elango et al., 2018), especially during the COVID-19 pandemic. For example, Maneewongse (2021) did research on behaviors and success factors of online teaching with LINE Application during COVID-19. Lertsakornsiri et al. (2021) examined factors affecting the students’ learning behaviors in online learning during the pandemic. Kornpitack and Sawmong (2022) studied factors influencing student satisfaction with online learning during the COVID-19 pandemic.

In online learning studies, researchers usually examine students’ adaptation and attitudes toward online learning, instructors’ behaviors, online learning environmental factors, and infrastructure readiness (Lertsakornsiri et al., 2021). Teo et al. (2014) studied tutor quality, perceived usefulness, and facilitating conditions in online learning. The study by Kornpitack and Sawmong (2022) examined performance expectancy, effort expectancy, social influence, learner interaction, facilitating conditions, behavioral intention, actual use, and student satisfaction. Moreover, Alqahtani and Rajkhan (2020) researched student characteristics, instructor characteristics, learning environment, instructional design, support, information technology, technology knowledge, course, and level of collaboration, while Elango et al. (2018) studied factors such as social influence, information quality, system quality, and function quality on usage intention of online education. Also, Khasasin et al. (2021) researched instructor, student, educational environment, and technology factors.

In this study, we decided to examine 32 factors from previous research, grouping them into five groups of factors which are 1) students’ personal opinions, 2) students’ attitudes toward online learning, 3) students’ attitudes toward instructors, 4) students’ attitudes toward courses, and 5) students’ perceptions of faculty and university readiness.

RESEARCH QUESTION AND HYPOTHESES

As mentioned earlier, this research aims to answer whether online learning is still necessary after the pandemic by studying factors affecting students’ preferences for the three learning formats, which are 1) 100% onsite, 2) 100% online, and 3) hybrid learning. This study tested hypotheses for the correlations between 32 learning factors and students’ evaluation of the appropriateness of each of the three learning formats in the post-pandemic situation. We categorized the 32 factors into five groups, five factors in the “students’ personal opinions” group, twelve factors in the “students’ attitudes toward online learning” group, six factors in the “students’ attitudes toward instructors” group, four factors in the “students’ attitudes toward courses” group, and five factors in the “students’ perception of faculty and university readiness” group. All the factors are shown in Table 1, and Figure 1 presents the research framework.



Source: This study.

Figure 1: Research Framework.

RESEARCH METHODOLOGY

Research Tool

An online questionnaire via Google Forms is the primary research tool in this study. The developed questionnaire has three parts. In the first part, students were asked to give demographic data such as gender, class year, and study major. In the second part, the 32 learning factors were listed in five groups, as shown in Table 1. the students rated their opinions on those factors by scoring from 1 (strongly disagree) to 10 (strongly agree). In the last part, the students gave appropriateness scores (from 1 to 10) on the three learning formats: 1) 100% onsite, 2) 100% online, or 3) hybrid learning. The first draft of this questionnaire was sent to eight students to test its validity and comprehensibility. Interviews with these eight students afterward indicated that the questionnaire was straightforward, easy to understand, and ready for data collection.

Table 1: English Version of the Questionnaire.

Factor Group		Factor
Students' Opinion	Personal	P1 - Traveling to study on campus is a waste of expenses.
		P2 - Traveling to study on campus is a waste of time.
		P3 - Traveling to study on campus is risky to contract COVID-19.
		P4 - Face-to-face interaction with friends is not important.
		P5 - Face-to-face interaction with teachers is not important.
Students' toward Learning	Attitudes Online	O1 - You are familiar with online learning.
		O2 - You can concentrate on studying when studying online.
		O3 - You can understand the content when studying online.
		O4 - You can follow the content when studying online.
		O5 - You can ask questions to instructors conveniently when studying online.
		O6 - You can contact instructors easily when studying online.
		O7 - You believe in the assessment system in online learning.
		O8 - You have no problem doing group work with friends online (e.g. via Zoom).
		O9 - You have the equipment and tools needed for online learning.
		O10 - You have network readiness for online learning (e.g. connection to the Internet).
		O11 - You have places to use for online learning, such as having rooms that are appropriate for studying online.
		O12 - You do not need to find accommodation in Bangkok (e.g. dormitories) when studying online.
Students' toward Instructors	Attitudes	I1 - Instructors use appropriate tools and teaching materials when teaching online.
		I2 - Instructors have appropriate teaching methods and practices when teaching online.
		I3 - Instructors can fully convey knowledge content when teaching online.
		I4 - Instructors organize teaching activities appropriately when teaching online.
		I5 - Instructors evaluate students appropriately when teaching online.
		I6 - You receive proper care from instructors in online learning.
Students' toward Courses	Attitudes	C1 - It is necessary to study theoretical courses onsite at the university.
		C2 - It is necessary to review the theoretical courses by watching video lectures.
		C3 - It is necessary to study practical/laboratory courses onsite at the university.
		C4 - It is necessary to review the practical/laboratory courses by watching video lectures.
Students' of Faculty and University Readiness	Perceptions	U1 - The faculty and university have the readiness in terms of software and systems for online learning.
		U2 - The faculty and university have provided sufficient equipment and tools for students who needed them for online learning.
		U3 - The faculty and university have provided sufficient Internet connections for students who needed them for online learning.
		U4 - The faculty and university have the readiness in terms of equipment and tools for Hybrid learning.
		U5 - The faculty and university have the readiness in terms of Internet connections for Hybrid learning.
Students' on the Appropriateness of Learning Format	Evaluation	E1 - 100% onsite learning is appropriate for the current situation.
		E2 - 100% online learning is appropriate for the current situation.
		E3 - Hybrid learning is appropriate for the current situation.

Source: Adapted from Alqahtani and Rajkhan (2020), Elango et al. (2018), Khasasin et al. (2021), Kornpitack and Sawmong (2022), Lertsakornsiri et al. (2021), Teo et al. (2014).

Population and Data Collection

We decided to base our study on students in the Department of Statistics, Chulalongkorn Business School, Thailand. This group of students has similar educational backgrounds and has to take similar groups of courses. For the academic year 2022, there are 463 students (131 first-year students, 125 sophomores, 101 juniors, and 106 seniors). One hundred fifty-eight students, or about 34.1% of the total, participated in the data collection via Google Forms during the first two weeks of September 2022, one month after the beginning of the academic year 2022. In other words, it is about one month after returning to onsite learning at the university. Table 2 shows the summary information of these 158 students. There are 63.3% females, 32.9% males, and 3.8% unidentified. The respondents are 29.1% freshmen, 31.0% sophomores, 15.8% juniors, and 24.1% seniors. 42.4% have a statistics/data science major, 29.7% have a Business IT major, and 27.9% have an insurance major. Regarding their preferred learning format, 27.8% chose 100% onsite learning, 28.5% chose 100% online learning, and 43.7% preferred hybrid learning.

Table 2: Respondents' Summary Information.

Demographics	Distribution
Gender	52 (32.9%) Male 100 (63.3%) Female 6 (3.8%) Unidentified
Class year	46 (29.1%) Freshman 49 (31.0%) Sophomore 25 (15.8%) Junior 38 (24.1%) Senior
Study major	67 (42.4%) Statistics/Data Science 47 (29.7%) Business IT 44 (27.9%) Insurance
The most preferable learning format	44 (27.8%) 100% Onsite learning 45 (28.5%) 100% Online learning 69 (43.7%) Hybrid learning

Source: This study.

RESEARCH RESULTS

Descriptive Statistics

Table 3 presents descriptive statistics of each factor presented earlier in Table 1. The mean values and standard deviation of each factor are calculated for each learning format. Mean values range from 2.16 to 9.57, while standard deviation values range from 0.90 to 3.29.

Table 3: Descriptive Statistics of Each Factor.

	Onsite		Online		Hybrid	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Students' Personal Opinions						
Traveling to study on campus is a waste of expenses.	6.75	2.66	7.58	2.39	7.13	2.53
Traveling to study on campus is a waste of time.	6.02	3.03	6.56	2.83	7.03	2.43
Traveling to study on campus is risky to contract COVID-19.	6.34	2.43	6.87	2.52	6.94	2.36
Face-to-face interaction with friends is not important.	2.32	1.87	2.16	1.89	2.36	1.57
Face-to-face interaction with teachers is not important.	2.80	2.29	2.73	2.24	3.06	2.02
Students' Attitudes toward Online Learning						
You are familiar with online learning.	7.30	2.67	7.64	2.40	8.13	1.82
You can concentrate on studying when studying online.	5.18	3.20	5.67	3.18	5.99	2.76
You can understand the content when studying online.	6.73	2.63	6.80	2.32	6.88	2.25
You can follow the content when studying online.	8.14	2.22	8.07	2.15	8.44	1.84
You can ask questions to instructors conveniently when studying online.	5.68	2.85	5.96	2.86	6.51	2.27
You can contact instructors easily when studying online.	5.32	2.74	6.44	2.42	6.41	2.17
You believe in the assessment system in online learning.	6.11	2.85	6.02	3.29	6.12	2.54
You have no problem doing group work with friends online (e.g. via Zoom).	6.55	2.75	6.29	3.29	6.71	2.53
You have the equipment and tools needed for online learning.	8.80	1.46	8.76	1.96	8.90	1.32

	Onsite		Online		Hybrid	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
You have network readiness for online learning (e.g. connection to the Internet).	8.50	1.90	8.51	1.50	8.57	1.71
You have places to use for online learning, such as having rooms that are appropriate for studying online.	7.80	2.43	7.87	2.63	7.99	2.21
You do not need to find accommodation in Bangkok (e.g. dormitories) when studying online.	8.75	2.54	7.96	3.07	8.38	2.35
Students' Attitudes toward Instructors						
Instructors use appropriate tools and teaching materials when teaching online.	8.23	1.85	8.27	1.53	8.12	1.56
Instructors have appropriate teaching methods and practices when teaching online.	8.07	1.87	7.91	1.58	8.10	1.46
Instructors can fully convey knowledge content when teaching online	7.09	2.31	7.38	2.07	7.41	1.74
Instructors organize teaching activities appropriately when teaching online.	7.84	1.98	7.42	2.08	7.62	1.70
Instructors evaluate students appropriately when teaching online.	7.66	1.90	7.33	2.60	7.77	1.62
You receive proper care from instructors in online learning.	6.93	2.19	7.27	2.02	7.15	1.75
Students' Attitudes toward Courses						
It is necessary to study theoretical courses onsite at the university.	5.61	3.20	5.20	2.74	4.39	2.63
It is necessary to review the theoretical courses by watching video lectures.	8.93	2.07	9.16	1.58	9.42	1.19
It is necessary to study practical/laboratory courses onsite at the university.	8.64	2.23	8.47	2.35	8.86	1.43
It is necessary to review the practical/laboratory courses by watching video lectures.	7.89	2.66	8.20	2.29	8.35	2.16
Students' Perceptions of Faculty and University Readiness						
The faculty and university have the readiness in terms of software and systems for online learning.	8.55	1.36	7.71	2.37	8.25	1.71
The faculty and university have provided sufficient equipment and tools for students who needed them for online learning.	7.66	2.08	7.44	2.25	7.73	1.98
The faculty and university have provided sufficient Internet connections for students who needed them for online learning.	7.77	2.09	7.40	2.06	7.59	1.82
The faculty and university have the readiness in terms of equipment and tools for hybrid learning.	7.98	2.15	8.47	1.73	8.30	1.74
The faculty and university have the readiness in terms of Internet connections for hybrid learning.	8.11	2.08	8.18	2.08	7.97	1.99
Students' Evaluation on the Appropriateness of Learning Format						
100% onsite learning is appropriate for the current situation.	6.18	2.85	5.91	2.56	5.10	2.58
100% online learning is appropriate for the current situation.	5.43	2.78	5.80	2.87	5.04	2.34
Hybrid learning is appropriate for the current situation.	8.73	1.53	9.27	1.45	9.57	0.90

Source: This study.

Hypothesis Testing

For hypothesis testing, we performed correlation analysis for each of the 32 factors in the five groups against students' evaluation of each learning format. The factors include E1 (100% onsite learning is appropriate for the current situation), E2 (100% online learning is appropriate for the current situation), and E3 (hybrid learning is appropriate for the current situation). The Pearson's correlation coefficients are shown in Tables 4 to 8, with hypothesis testing results at 95% and 99% confidence levels.

Table 4: Correlation Coefficients between Students' Personal Opinions and Evaluation of Each Learning Format.

Students' Personal Opinion	Onsite	Online	Hybrid
Traveling to study on campus is a waste of expenses.	-0.194*	0.454**	0.081
Traveling to study on campus is a waste of time.	-0.369**	0.425**	0.159*
Traveling to study on campus is risky to contract COVID-19.	-0.189*	0.281**	-0.041
Face-to-face interaction with friends is not important.	-0.492**	0.304**	-0.040
Face-to-face interaction with teachers is not important.	-0.497**	0.311**	-0.015

Source: This study.

* significant at 95% confidence level

** significant at 99% confidence level

For factors in the "Students' Personal Opinions" group, Table 4 indicates that for students who prefer 100% onsite learning, face-to-face interactions with teachers and friends are significantly important to them. They do not think travelling to university wastes time or money, and it is not risky to contract COVID-19, which is the opposite of those who prefer 100% online learning.

Table 5: Correlation Coefficients between Students' Attitudes toward Online Learning and Evaluation of Each Learning Format.

Students' Attitudes toward Online Learning	Onsite	Online	Hybrid
You are familiar with online learning.	-0.369**	0.367**	0.052
You can concentrate on studying when studying online.	-0.458**	0.477**	0.042
You can understand the content when studying online.	-0.414**	0.354**	0.046
You can follow the content when studying online.	-0.278**	0.232**	0.140
You can ask questions to instructors conveniently when studying online.	-0.256**	0.279**	0.055
You can contact instructors easily when studying online.	-0.230**	0.244**	0.087
You believe in the assessment system in online learning.	-0.257**	0.468**	0.061
You have no problem doing group work with friends online (e.g. via Zoom).	-0.161*	0.366**	0.007
You have the equipment and tools needed for online learning.	-0.199*	0.290**	0.137
You have network readiness for online learning (e.g. connection to the Internet).	-0.094	0.284**	0.098
You have places to use for online learning, such as having rooms that are appropriate for studying online.	-0.157*	0.311**	0.057
You do not need to find accommodation in Bangkok (e.g. dormitories) when studying online.	-0.029	0.149	0.078

Source: This study.

* significant at 95% confidence level

** significant at 99% confidence level

For factors in the "Students' Attitudes toward Online Learning" group, Table 5 shows that students who prefer 100% onsite learning have significantly negative attitudes toward online learning in almost all aspects. On the other hand, students who prefer 100% online learning have significantly positive attitudes toward online learning. Interestingly, for students who prefer hybrid learning, factors in this group do not significantly affect their choice of learning format.

Table 6: Correlation Coefficients between Students' Attitudes toward Instructors and Evaluation of Each Learning Format.

Students' Attitudes toward Instructors	Onsite	Online	Hybrid
Instructors use appropriate tools and teaching materials when teaching online.	-0.009	0.247**	0.128
Instructors have appropriate teaching methods and practices when teaching online.	0.011	0.279**	0.008
Instructors can fully convey knowledge content when teaching online.	-0.270**	0.391**	0.083
Instructors organize teaching activities appropriately when teaching online.	-0.047	0.338**	-0.032
Instructors evaluate students appropriately when teaching online.	-0.121	0.407**	0.109
You receive proper care from instructors in online learning.	-0.133	0.370**	0.066

Source: This study.

* significant at 95% confidence level

** significant at 99% confidence level

Table 6 indicates that students who prefer 100% online learning have significantly positive attitudes toward their instructors teaching online. In comparison, students who like 100% onsite learning feel that their instructors cannot fully convey the knowledge content when teaching online.

Table 7: Correlation Coefficients between Students' Attitudes toward Courses and Evaluation of Each Learning Format.

Students' Attitudes toward Courses	Onsite	Online	Hybrid
It is necessary to study theoretical courses onsite at the university.	0.483**	-0.222**	-0.100
It is necessary to review the theoretical courses by watching video lectures.	-0.145	0.109	0.352**
It is necessary to study practical/laboratory courses onsite at the university.	0.187*	-0.328**	-0.032
It is necessary to review the practical/laboratory courses by watching video lectures.	0.161*	0.048	0.150

Source: This study.

* significant at 95% confidence level

** significant at 99% confidence level

The results in Table 7 indicate that students who prefer 100% onsite learning want to study all courses on campus (both theoretical and practical/laboratory). Similarly, students who prefer 100% online learning want to study all courses online. Students who prefer hybrid learning feel it is essential to review the theoretical courses by watching video lectures.

Table 8: Correlation Coefficients between Students' Perceptions of Faculty and University Readiness and Evaluation of Each Learning Format.

Students' Perceptions of Faculty and University Readiness	Onsite	Online	Hybrid
The faculty and university have the readiness in terms of software and systems for online learning.	0.030	0.173*	0.140
The faculty and university have provided sufficient equipment and tools for students who needed them for online learning.	0.117	0.197*	0.074
The faculty and university have provided sufficient Internet connections for students who needed them for online learning.	0.060	0.189*	0.100
The faculty and university have the readiness in terms of equipment and tools for hybrid learning.	-0.043	0.112	0.289**
The faculty and university have the readiness in terms of Internet connections for hybrid learning.	0.012	0.197*	0.275**

Source: This study.

* significant at 95% confidence level

** significant at 99% confidence level

Since the beginning of the COVID-19 pandemic, Chulalongkorn University has provided students and instructors with tools and services for online and hybrid learning. These include Learning Management Systems such as Blackboard and myCourseVille, as well as online meeting services such as Zoom Cloud Meeting, Microsoft Teams, and Google Meet. Moreover, Chulalongkorn University has arranged computers and notebooks for students to borrow for online and hybrid learning. Concerning the faculty and university readiness, Table 8 indicates that students who prefer hybrid learning feel that the faculty and university are ready for hybrid learning in terms of equipment, tools, and Internet connections.

Table 9 to Table 11 show the top most related factors to each learning format. In this case, we consider both negative and positive correlation coefficient values.

Table 9: Top 5 Most Related Factors to Appropriateness of 100% Onsite Learning.

Factors Most Related to 100% Onsite Learning	Correlation Coefficient
P5: Face-to-face interaction with teachers is not important.	-0.497**
P4: Face-to-face interaction with friends is not important.	-0.492**
C1: It is necessary to study theoretical courses onsite at the university.	0.483**
O2: You can concentrate on studying when studying online.	-0.458**
O3: You can understand the content when studying online.	-0.414**

Source: This study.

* significant at 95% confidence level

** significant at 99% confidence level

For 100% onsite learning, Table 9 shows that students' personal opinions (P5 and P4) are the most related factors to their preferences for onsite learning. They value face-to-face interactions with teachers and friends. Moreover, they feel they cannot concentrate or understand the content when studying online (O2 and O3).

Table 10: Top 5 Most Related Factors to Appropriateness of 100% Online Learning.

Factors Most Related to 100% Online Learning	Correlation Coefficient
O2: You can concentrate on studying when studying online.	0.477**
O7: You believe in the assessment system in online learning.	0.468**
P1: Traveling to study on campus is a waste of expenses.	0.454**
P2: Traveling to study on campus is a waste of time.	0.425**
I5: Instructors evaluate students appropriately when teaching online.	0.407**

Source: This study.

* significant at 95% confidence level

** significant at 99% confidence level

The findings in Table 10 indicate that the most related factors to students' preferences of 100% online learning are mostly students' personal opinions (P1 and P2) and attitudes toward online learning (O2 and O7).

Table 11: Top 4 Most Related Factors to Appropriateness of Hybrid Learning.

Factors Most Related to Hybrid Learning	Correlation Coefficient
C2: It is necessary to review the theoretical courses by watching video lectures.	0.352**
U4: The faculty and university have the readiness in terms of equipment and tools for hybrid learning.	0.289**
U5: The faculty and university have the readiness in terms of Internet connections for hybrid learning.	0.275**
P2: Traveling to study on campus is a waste of time.	0.159*

Source: This study.

* significant at 95% confidence level

** significant at 99% confidence level

The need to review the theoretical courses by watching video lectures (C2) is the most related factor for preferences for hybrid learning. Also, factors in the "Students' Perception of Faculty and University Readiness" (U4 and U5) appear in the second and third ranks.

DISCUSSION AND CONCLUSION

It can be concluded from the study that even after the situation of the COVID-19 pandemic begins to unravel and the learning format is back to a 100% onsite-classroom environment, some students still prefer 100% online learning. Findings from this study indicate that factors related to preferences for online learning are mostly students' personal concerns about expenses and time to travel to study on campus. This group of students can concentrate and understand the content well when studying online, and they do not value interactions between students and teachers or friends. On the other hand, students who do not want online learning cherish interaction among teachers and friends. They want to understand the content of courses and believe they cannot achieve it when they study online. For hybrid learning, most students feel it is something nice to have. The primary purpose of hybrid learning is to revise the course content by watching video lectures. The findings of this study can be used as guidelines for teachers and educational institutions to gain more understanding of their students and ultimately provide them with the most suitable learning formats. Future research can be conducted with students in different faculties and groups. Details analysis by gender and study major are also interesting.

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Key factors of adopting energy management systems in building sector in Taiwan

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ABSTRACT

It is no doubt the world is experiencing global warming and human emission causes distinct climate change. According to the analysis from International Energy Agency, the over consumed nature resources from power, industry, transport and building sectors are off the major factors reflecting on the essential greenhouse gases to life. As moving onto the smart technology and smart grid development, recent studies indicate that using the advanced energy management systems is critical to improve power efficiency, energy saving, and reduce greenhouse gas emission. This study relies on a systematic literature review and expert opinion to identify the critical factors of adoption building energy management system. Finally, a framework is presented to evaluate the introduction of energy management systems in the construction field in order to achieve zero carbon ready buildings.

Keywords: Zero carbon ready building, Nearly zero energy buildings, Building energy management Systems, BEMS, Energy Management Systems, TOE.

INTRODUCTION

Climate Change

In 2022 scientists observed a raising temperature upto 40 degrees centigrade in the United Kingdom, already 28 years ahead of scientific prediction. Additionally, the uncommon high temperature observed in Nordic area, especially in Sweden, for over one week. Nowadays the extreme abnormal weather causes the environment changes, for example heat waves, drought, tsunami, hurricanes, melting polar ice caps, icy coastal decline, forest fires, and raising sea level...etc of that driving grand attention to problems of global warming syndrome.

Most of scholars' researches revealed radiation release from atmosphere, and heat trapping gases over planet are conducive to greenhouse effect. Carbon dioxide has increased 25% out of origin since 1850 while human activities reacted on overheating fossil fuels, landfills burning, and deforestation. The key factors of greenhouse effect (CO₂, methane, nitrous oxide, and CFC/HFC..etc) grew times above average level on earth. In between 2010 and 2019 we witnessed challenges on the severe problem of global warming effect, and percentage of CO₂ ratio hit the highest record in 650,000 years (Berger & Tricot, 1992; Bouckaert et al., 2021; IEA, 2020; Raval & Ramanathan, 1989; Rodhe, 1990).

The Intergovernmental Panel on Climate Change (IPCC) reports that scientific studies on the impact of global warming reaches world record high since 1950, especially researches on climate changes of hydrosphere, cryosphere decline, severe raising sea level damaging biosphere safety. Solution for mitigating rampant climate change, or rather say "climate crisis" have been groundwork for catering for a resolution, replacing general concept on global warming effect (Houghton et al., 2001).

Net-Zero Emissions (NZE)

IPCC report on "Global Warming of 1.5 °C" indicates that the speed of global warming transcends scientific prediction. It is of no doubt all member states shall limit carbon emission release in half before 2030, and the additional suggestion on global warming emission be strictly controlled less than 1.5 °C, based on the benchmark of average global temperature in 1990s. Approaching this target on Net Zero emission be of the milestone before 2050, in order to tackle mundane impact and challenge on climate change (IPCC, 2018).

In May 2021, the International Energy Agency (IEA) report for mission on "2050 Net Zero Emission Roadmap" indicates among total 33.9Gt (Gigatons) of global Greenhouse Gas (GHG) of which 13.5Gt (share 39.7%) from Energy sector, 8.5Gt (share 25%) from Industries, 7.9Gt (share 21.2%) from Transport, 2.9Gt (share 8.5%) from building, and others for 1.9Gt (share 5.6%). Meanwhile fossil fuels occupy 80%, and consumption on coal mining, natural gas, and gasoline are increasing, exceeding 60% of total power distribution that de factor be of major impact on climate change (Bouckaert et al., 2021; IEA, 2020). Thus, framework for targeting on Net Zero Emission Roadmap narrows down on these four major sectors: power, energy, industry, transport, and building.

Furthermore, the IEA report on achieving Net-Zero Emissions codes all member states to comprehensively comply within thirty years: efficiently optimize power consumption, adjust humane behaviors, replace by renewable and sustainable energy,

decline on fossil fuels, gas, and oil usage, deploy the available clean energy technologies, implementing energy control & monitoring system, purposely focus on limiting greenhouse emission.

Therefore, providing smart grid technology and smart building with diversified Energy Management System (EMS) be of the key solutions of that real-time data record demonstrates power utility, amending energy using behaviors, optimizing power consumption in order for reaching Net-Zero Emission, and upcoming GHG emission target.

Improving the efficiency of power consumption in building sector, and developing green and clean energy buildings drive attention to deploy high-tech solutions, the energy management system, smart meter, and micro grid, aiming to provide zero carbon ready buildings.

LITERATURE REVIEW

Energy Management System

Maghsoodlou et al. (2004) stated that the energy management system (EMS) is the core system of the power network system, and the EMS is the key facility for the power grid control center to maintain the power utility's reliable operation. EMS is one console mechanism that the tool monitors and manages power utility, the "Supervisory Control and Data Acquisition (SCADA)", efficiently generates power by concise analysis and computing, transmits and distributes power to end demand side in a greater production. The EMS aims to enhance operations of power utility, such as adjusting power stream, the utmost utility of power consumption, monitoring real-time power sub-stations, and efficiently transmitting and control operation safety. Especially, the advanced EMS system also grants higher computing power for optimization (Abhinav & Pal, 2018; Garrick, 2008; Tran et al., 2021).

Due to the rapid development of smart grid, micro grid, smart meters and IoT solutions, EMS has been deployed in variety of industrial scales, such as building energy management system (BEMS), factory energy management systems (FEMS), and home energy management system (HEMS).

By actively collecting data of power measurement on physical side, for example providing information referring to real-time power consumption, kernel for utilizing on networking resources, monitoring the abnormal events, and decision support, the facility manager easily operates whole power grid and demand facility. Buildings that integrate EMS achieve unattainable levels of energy savings after the EMS implementation. (Budka et al., 2016; Mahajan et al., 2021; Paul et al., 2014; Segatto & de Oliveira, 2018; Shrouf & Miragliotta, 2015; Shrouf et al., 2014; Yang et al., 2017).

According to prior researchers' examination, the advanced BEMS system enables well management on power utility, and the change for interior amenity. For example, auto-adjust interior lightning, interior ventilation, and humidity or temperature. More, comparing the stereotype concretes, BEMS embedded buildings reduce 30% of power consumption, achieving the innovation, smart and energy saving target with amicable amenity (Aarås et al., 2001; Desideri & Asdrubali, 2018; Fisk, 2000; Noye et al., 2016; Pérez-Lombard et al., 2008).

Zero carbon ready building

According to the IEA report, the building sector has large carbon footprint with about 9% CO₂ emissions from using fossil fuel energy, 18% from electricity and heat used, and an additional 10% from the manufacturing of construction materials (IEA, 2021).

D'Agostino and Mazzarella (2019) studied the national energy policies by introducing technical regulatory measures to improve the energy efficiency of buildings and the generation of renewable energy sources (RES). Reducing the energy demand by using RES and using energy efficiently have achieved common agreement to the nearly zero energy buildings (NZEB) concept.

According to the International Energy Agency, "A zero-carbon-ready building is highly energy efficient and either uses renewable energy directly or uses an sustainable energy supply that will be fully decarbonised by 2050, such as electricity or district heat (Bouckaert et al., 2021)." Before reaching zero carbon ready buildings, IEA initiated "enhancing development and projects of nearly zero energy buildings" since 2019, and by 2021, it provides technical guidance for nearly zero energy buildings, including definition, energy criteria, technical performance index, technical measures, and evaluation.

To meet the Net Zero Emissions by 2050 Scenario, the energy intensity of the building sector must fall nearly five times faster over the next ten years than it did in the previous five years. This means that in 2030, the energy consumed per square meter must be 45% lower than that in 2020. Furthermore, the traditional use of solid biomass, which is extremely inefficient and has been linked to approximately 2.5 million premature deaths from household air pollution in 2020, should be phased out completely by 2030. By shifting to modern solid biomass, biogas, electricity, and liquefied petroleum gas (LPG), the Net Zero Emissions by 2050 Scenario achieves universal energy access by 2030 (IEA, 2021).

Another action conducive to achieve Net Zero Emissions by 2050 scenario is implementing mandatory zero-carbon-ready building codes for all new buildings by 2023. These standards should cover both operational and construction-phase energy

intensity and emissions, in line with the most recent EU policy developments such as France's new RE2020 standard. The new buildings compliance with the zero-carbon-ready building code should include EV charging, demand management, help buildings to accommodate variable renewable energy sources and a net zero electricity system (IEA, 2021).

Substantially the investment and spending has increased, it is inherently challenging to have triple investment by 2030 to achieve the Net Zero Emissions by 2050 scenario's milestones of reaching deep energy retrofit rate of ~2.5% per year. IEA also suggest that all the new buildings need be Net Zero Emissions ready to meet the 2050 goal.

TOE framework

When researching organizational acceptance of technological innovation, Tornatzky et al. (1990) proposed the technological organizational environmental (TOE) framework and concluded that the influencing factors fell into three categories: organization, technology, and environment. It describes the entire innovation process, from innovation development by engineers and entrepreneurs to adoption and implementation of those innovations by users within the context of a firm. The TOE framework represents one aspect of this process, namely how the firm context influences innovation adoption and implementation.

Alshamaila et al. (2013) The TOE framework is an organizational-level theory that explains how innovations are adopted and implemented. These are three elements posited to influence firm technological innovation, and those discussed below.

Technology

The technological context of the firm represents its technological capability, both internal and external. Those technologies are already in use at the firm, and others are available on the market but are currently unutilized.

Organization

The organizational context is related to the resources, cultures, and characteristics of the firm such as executive board, professionals, firm size, managerial structure.

Environment

Environmental context refers to the environment where a company operates including elements cohering with regulation, supply chain, competitors, and industry alignment.

The TOE framework proposes that factors influencing innovative information system (IS) or technology adoption behavior can be broadly classified into three contexts: technological, organizational, and environmental. Many scholars have used the TOE framework to explore various innovative technology adoptions in many technology or industry territories, because it is a comprehensive organizational level research theory for investigating new technology intentions.

RESEARCH DESIGN

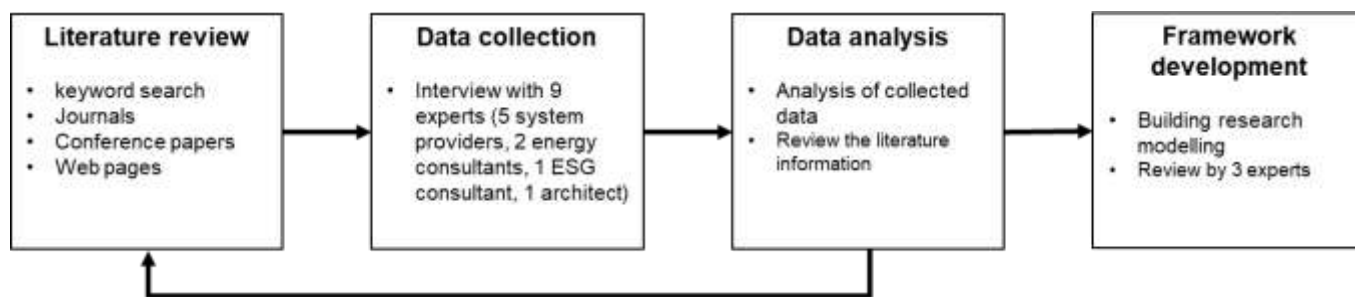
This research design is illustrated Figure 1.

First, approaching search engine (Google Scholar, ScienceDirect, and Elsevier) to select documents of literature review, analyzing theoretical frameworks referring to adopting building energy management system (BEMS), and the improvement of building energy efficiency. By doing so includes critical evaluation of BEMS definitions, technologies and smart building applications. For the purpose, several keywords are used in the search process, such as "energy management system," "building energy management system," "adopt energy management and TOE", "BEMS and TOE", "TOE and adopt information technology" and "TOE and adopt cloud applications".

Second, given the nature of this research paper purposely for a qualitative research approach, based on regular interviews through concept of data collection, ie. the interview on nine expertise. There are five executives of technology and solutions providers: two presidents, one engineering director, and two professional electric & electronic experts. Except the above five executive professionals we also include two consultants from energy sector, one V.P of ESG Consulting Group International, and one experienced architect.

Third, compare the prior Literature review reference with data collection interviews analyze similarities among materials, examine relativities, and root cause of research orientation, aiming at simulating and building up frame work models.

Last but not least, relying on the literature review and interviews, inductive modeling is adopted to build a framework for enterprise energy management system, so as to define how energy information is able to integrate into construction projects and property operation.

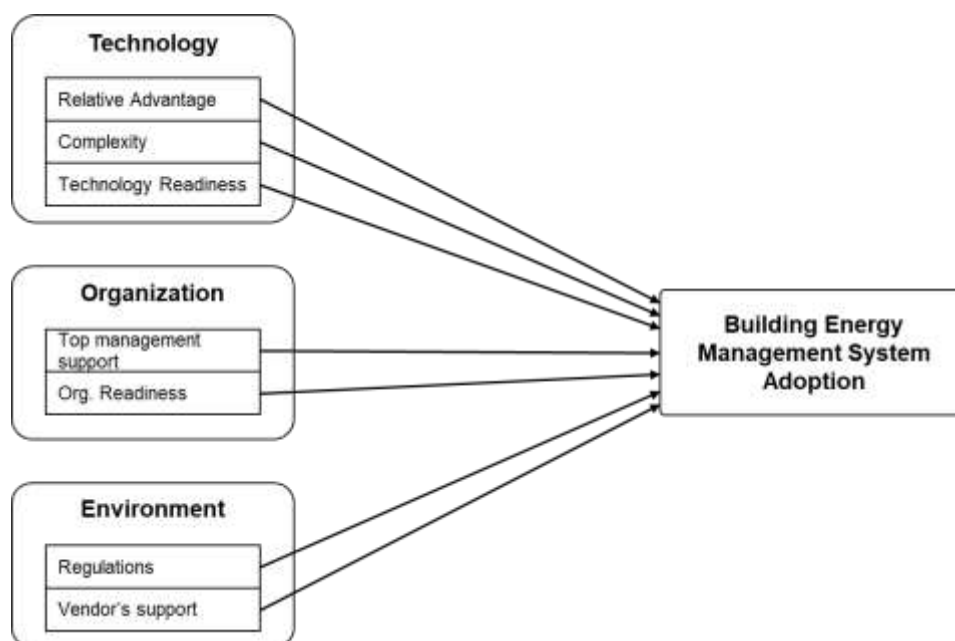


Source: This study.
Figure 1: The research design.

RESULTS DISCUSSIONS

By conducting a literature review to identify potential factors, driving those construction companies’ adaptation for energy management system, this study then assesses the importance of those factors through interview with experts. In the end, the study proposes the analysis model to explain the key factors of companies to adopt BEMS referring to pervious modifying TOE framework (Gangwar et al., 2015; Hung et al., 2014; Premkumar & Roberts, 1999; Pumplun et al., 2019; Ramdani et al., 2009).

In order to make an in-depth analysis, this study targets those construct company and building operation’ that adopts energy management system. As to the variables definition, all of the operational definitions and assessment are derived from the relevant literature. The operational definition of variables are summarized in Table 1, and the research model is illustrated in Figure 2.



Source: This study.
Figure 2: The framework from lecture.

Technology Context

Relative Advantage

Rogers et al. (2014) define relative advantage as “ the degree to which a technological factor is perceived as providing greater benefit for firms”. Premkumar and Roberts (1999) also study that with these technological factors, the adopters can enjoy the benefits which reduce turn-around time, lower down the cost, provide higher customer service level, get timely information for making decisions. By Alshamaila et al. (2013), the relative advantage on technology adoption has been widely accepted in all kinds of previous studies. In organizations, having an advanced technology which provide better benefits than other alternatives is a key consideration in adoption for the decisions. Bandara and Amarasena (2018) study found that relative advantage, perceived behavior control, and perceived ease of use are positive factors to influence the adoption of new solar technology.

Adopting new technology has a higher relative advantage than maintaining existing technologies. In the study of Premkumar and Roberts (1999) and Ramdani et al. (2009), it was considered that the idea of innovation is better than the idea of been

replaced. The study found that the relative advantage is such a critical factor and it is positively related to the adoption of innovative technology. Before the organization taking a new technology, it requires reasonable evaluation. When the organization perceives the new information system (IS) that provides relative advantage, it grants better opportunities to be adopted. Especially among highly competition industries, adopting to new technology which has relative advantage can benefit from increasing sales revenue, improving the process or lower down the operation and management cost. Those benefits become important driving factors pushing industries for adopting new technologies (Alshamaila et al., 2013; Gangwar et al., 2015; Lee, 2004; Markus & Tanis, 2000; Valdebenito & Quelopana, 2019).

This study intentionally summarizes those previous researched and defines the relative advantage as “the advantages and competitive abilities of company to enjoy after the adoption of a new energy management system compare to before the adoption. Such advantages and competitive potentials are aim to realize the zero carbon ready building”.

Table 1: The definition of Adopting building energy management system.

Context	Factor	Description	References
Technology	Relative Advantage	the advantages and competitive abilities of company to enjoy after adoption of a new energy management system compare to before the adoption. Such advantages and competitive potentials are aim to realize the zero carbon ready building.	Alshamaila et al. (2013); Bandara and Amarasena (2018); Gangwar et al.(2015); Lee (2004); Markus & Tanis (2000); Premkumar & Roberts (1999)
	Complexity	the degree of understanding new technology and the ability to fine-tune and improving the technology after adoption.	Beaudin and Zareipour (2015); Grover (1993); Parveen & Sulaiman (2008); Ramdani et al. (2009); Thong (1999)
	Technology Readiness	supporting companies' eco demands which have the key driving factors including to build up green technology infrastructure and the IT process to support low carbon emission.	Molla et al. (2008); Mutula and Van Brakel (2006); Parasuraman (2000); Valdebenito and Quelopana (2019)
Organization	Top Management Support	the commitment and support from top management to adopt energy management system, which provide resource for the organization and belonged buildings to achieve energy-saving and eco-friendly goal.	Britel and Cherkaoui (2022); Gangwar et al. (2015); Jovanović & Filipović (2016); Salwani et al. (2009); Zhang et al. (2018)
	Organization Readiness	the capabilities and resources for companies to adopt energy management system which including training, financial readiness, organization culture and management process.	Britel and Cherkaoui (2022); Lokuge et al. (2019); Ramdani et al. (2009); Valdebenito and Quelopana (2019)
Environment	Regulations	government's deadline to implement energy reduction and nearly zero energy buildings (NZEBs), and also the government incentives for building companies to adopt energy management system (EMS) or other innovation technology.	D'Agostino and Mazzarella (2019); IEA (2021); Pumplun et al. (2019); Salwani et al. (2009)
	Vendor's support	the capabilities of a supplier to provide EMS and technology, deliver knowledge and supporting service.	Dedrick & West (2003); Gutierrez et al. (2015); Lal and Bharadwaj (2016); Maghsoodlou et al. (2004)

Source: This study.

Complexity

The complexity was defined as “the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters (Rogers et al., 2014).” Sonnenwald et al. (2001), “Complexity is defined as the perceived degree of difficulty on understanding and using a system.”

Premkumar and Roberts (1999) study found that complexity is the degree of difficulty associated with understanding and learning to transform into innovation immediately. The complexity of the innovated technology creates greater uncertainty for successful implementation, and therefore increases the risk in the adoption decision.

The complexity of innovated technology will increase the uncertainty of adopting a new technology. Some studies focus on the factor of decision risk of adoption of new technology and system. According to previous study, such decision risk factor is negative related to adopting a new information system. Similarly the decision risk is also an important factor for small enterprise's adoption of new IS (Gangwar et al., 2015; Grover, 1993; Parveen & Sulaiman, 2008; Thong, 1999).

Beaudin and Zareipour (2015) addresses that each equipment has its own attributes, even some studies try to modeling the home energy system (HEMS) and simplify the operation process, it is still difficult to figure out an intuitive model to manage

various equipment. Especially there are still kinds of external environmental limitation and different operating criteria and complexity. To improve setting up the management system is fairly necessary.

This study defines the “Complexity” as “the degree of understanding new technology and the ability to fine-tune and improving the technology after adoption.”

Technology Readiness

Information technology (IT) has the potential to influence not only competitive capability, but also business development and even the parts of corporate strategic options. Most executive officers and IT managers are dealing with two competing demands: First, to establish a stable information infrastructure will support business processes smoothly; the other, to import cutting edge information system provides the most innovative business services.

Parasuraman (2000) defined technology readiness as “the propensity to embrace new technology for accomplishing goals is determined by the overall state of mind resulting from a gestalt of mental contributors and inhibitors.” This study classifies organizations into five segments on the basis of accepting technology readiness from explorers who are the first to adopt technology to laggards who possess few motivations toward technology and typically would be the last group to adopt a new technological service or product.

Molla et al. (2008) study about what does it take for organizations using IT to succeed in this increasingly low carbon economy and global green movement? Valdebenito and Quelopana (2019) also identify the technology readiness is also a mature index to evaluate an organization’s IT and management capability. Mutula and Van Brakel (2006) study figured out when the organization wanted to develop new service or business, its information and digital readiness should include solution for information and communication Technology (ICT) readiness, information readiness, and human resource readiness.

In the progress of entering into environmental sustainability, we define “technology readiness” as “supporting companies’ eco demands which have the key driving factors to build up green technology infrastructure and the IT process to support low carbon emission.”

Organization Context

Top management support

Gangwar et al. (2015) recognized the top management’s role of initiation, implementation and adoption of information technologies. Premkumar and Roberts (1999) found that it is critical to have top management support to create a supportive climate and provide adequate resources for adoption of new technologies.

Salwani et al. (2009) explains top managers’ perception and action prone to the usefulness of technological innovation is critical in creating values for the firm. With top manager’s precision and actions, it creates long-term vision, reinforcement of values, commitment of resources, cultivation of favorable organizational climate, higher assessments of individual self-efficacy, support in overcoming barriers and resistance to the organization change.

Zhang et al. (2018) study found that even Chinese government has set up several energy policies, many companies still not to adopt proactive energy-saving activities. It indicates that the supporting from top management and through command orders and process will directly impact the companies to take actions on energy-saving activities.

Britel and Cherkaoui (2022) also study the automotive industry cases and find out the major factors impacting the technology readiness are sequentially ranked with top management attitude, employee involvement, resource invested by the organization, organization commitment, organization benefits, easy of organizational change.

Many studies explain commitments and leadership from top management are critical important too. It sets up the organization’s vision and policies to ensure the organization can continue aiming to improve the energy system, provide necessary resource, build up cross-functional team, and bridge the communication, involve the employee to take actions on energy-saving (Cagno & Trianni, 2014; Finnerty et al., 2017; Fuchs et al., 2020; Jovanović & Filipović, 2016; Karcher & Jochem, 2015; Trianni et al., 2016).

In this study, we consider the “top management support” is an important factor. We define it as “the commitment and support from top management to adopt energy management system, which provide resource for the organization and belonged buildings to achieve energy-saving and eco-friendly goal.”

Organization Readiness

In study by Valdebenito and Quelopana (2019), it indicated the organization readiness is the index of the technology and financial resource. It includes two sub-factors of financial readiness and technical readiness. Financial readiness is the indicator of new system implementation and maintaining cost. Technical readiness is the indicator for maturity of IT technology adoption and management ability. The organization readiness can be used on evaluating whether to adopt cloud service. Only

when a company is ready at infrastructure, technology, and financial supporting, then the company will take cloud service as part of the company's value chain activities.

Britel and Cherkaoui (2022) study the automotive industry's adoption of ISO50001 energy management system. They found that if the companies can have the organization readiness as a reference tool, it helps top managers to make decision and define the organization change scope and enforce the supporting actions. It results in lower down the failure risk of organization change.

Digital technology has empowered the organization's innovation capabilities. However, many organizations are still not ready for such innovations due to assessment of investment. Almost 90% of new ideas never been transferred into new products or service. In Lokuge et al. (2019) organization readiness model, it uses seven dimensions to identify the organization readiness which including: resource readiness, cultural readiness, strategic readiness, IT readiness, innovation valance, cognitive readiness, and partnership readiness.

In this study, we define "organization readiness" as "the capabilities and resources for companies to adopt energy management system which including training, financial readiness, organization culture and management process. When companies cannot have necessary technical and financial support to satisfy the innovation request from internal resources, it can also have supports from outside 3rd parties."

Environmental Context

Regulations

Salwani et al. (2009) explore the external factors such as government incentives and regulations that may have significant impacts on a company's business operations. According to D'Agostino and Mazzarella (2019), introduction for new polices with technical and regulatory measures led to more rational use of energy. Such kinds of implementation also reflected on savings of European buildings. Nearly zero energy buildings (NZEBs) is one of the key measures for the index of new buildings. Pumplun et al. (2019) indicates that many laws complicate the introduction and use of AI. A renewal of the legal situation is demanded. The study also points out the government regulations may be both positive and negative effects on innovation adoption.

According to the EU's Net Zero Emissions policy, the zero carbon ready buildings standard will be implemented for all new buildings by 2030, covering both operational and construction-phase energy intensity and emissions (IEA, 2021). This is a demonstration of the government's policy, or regulations that would be accelerated to force enterprises to engage in more transformation activities.

Regulations and governments incentives may drive companies' organization change and innovation. In this study, we define "regulations" as "government's deadline to implement energy reduction and nearly zero energy buildings (NZEBs), and also the government incentives for building companies to adopt energy management system (EMS) or other innovation technology."

Vendor's Support

Dedrick and West (2003) study illustrated the real cases and found that most companies consider the support from suppliers is important. Especially for those big organizations who are used to adopting IT service and maintaining service. With the suppliers' technical support and service, those big organizations will be more intending to adopt new open source software.

Maghsoodlou et al. (2004) indicated that in most automatic power service networks of public utility were set up by system suppliers. And those suppliers collect operation data and operational problems in a long-term period. This makes the suppliers accumulate experience and knowledge which empower strong supporting capability during the system operation. Besides, in topics of service quality control and information security, those suppliers and its consultant play a critical role in improving the operation system.

Gutierrez et al. (2015) study UK's cloud service cases and found that who is the service provider will play an important role for corporations to decide whether to adopt a cloud service. Lal and Bharadwaj (2016) also identified that small and medium company usually worry about whether can trust the suppliers in making decision about adopting a new software system into their mission critical tasks. Thus, the reputation of supplier becomes a critical factor in companies' decision of adopting a cloud service.

This study defines "vendor's support" as "the capabilities of a supplier to provide EMS and technology, deliver knowledge and supporting service." Through the "supplier's supporting capability", it can speed up the setup time, quick to operation, realize the benefits of new energy management system and improve the building's energy efficiency.

CONCLUSION

Energy management system is a significant instrument for increasing a building's energy efficiency, adopting EMS would aid in meeting the NZEB goal. In order to achieve Net Zero Emissions by 2050 Scenario, it is important to study factors

influencing adoption building energy saving for promoting zero carbon ready building. Relying on the literature review and interviews, inductive modeling was adopted to build a framework to understand which variables are the critical factors of EMS adoption in building sector. Adopting energy-saving technology is also an important way for building to reduce greenhouse gases. Considering the differences between technology, organization and environment contexts, future research can study detail factors and adoption behavior.

We focus on influencing factors of building energy management system adoption in this paper. The value of such framework and contribution of the paper aim at adopting to new innovated technology and further practice, in order to target net-zero building emission mission. First, the paper examines literature review for effects. Additional, through data collection of experimental interviews with professionals and expertise, a preliminary assumption suggests a perceivable framework tailored. Third, by data analysis to adopt to high advanced technology propose EMS mechanism works for improving building energy efficiency and mitigating carbon emissions as reaching zero carbon ready building. Last but not least, building up a framework and research to excite accepting the deployment and development of new innovated technology, purposely in business grow, optimizing power consumption, and energy saving of the buildings, targeting to zero carbon ready building, and green environment.

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Measuring the modeling complexity of microservice choreography and orchestration: The case of e-commerce applications

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ABSTRACT

Context: With the increasing popularity of microservices for software application development, businesses are migrating from monolithic approaches towards more scalable and independently deployable applications using microservice architectures. Each microservice is designed to perform one single task. However, these microservices need to be composed together to communicate and deliver complex system functionalities. There are two major approaches to compose microservices, namely Choreography and Orchestration. Microservice compositions are mainly built around business functionalities, therefore businesses need to choose the right composition style that best serves their needs. Hence, this research uses existing complexity metrics from the software engineering and business process modeling domains on small, mid-sized, and end-to-end e-commerce scenarios to analyze and compare the level of complexity of microservice Orchestration and Choreography using Business Process Modeling Notation (BPMN).

Objective: Comparing the complexity of the two leading composition techniques on small, mid-sized, and end-to-end e-commerce scenarios, using complexity metrics from the software engineering and business process literature. More specifically, we use the metrics to assess the complexity of BPMN-based models representing the abovementioned e-commerce scenarios.

Method: This research follows a five-step process for conducting a Design Science Research (DSR) methodology to define, develop and evaluate BPMN-based models for microservice compositions.

Results: A series of BPMN workflows are designed as artifacts to investigate microservice Choreography and Orchestration. The results derived from the complexity evaluation of our proposed models show a higher level of complexity in orchestrating microservices for e-commerce applications given the number of services used in modeling Orchestration compared to Choreography.

Conclusion: This research uncovers insights on modeling microservice Choreography and Orchestration and discusses the impacts of complexity on the modifiability and understandability of the proposed models.

Keywords: Microservice, Microservice Composition, Choreography, Orchestration, Complexity Metric, BPMN.

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INTRODUCTION

There has been an ongoing progress in the architecture of software systems over the last few decades, leading to a need for more distributed and modularized systems. Such advancement in software architecture has shifted service-oriented computing towards a more loosely coupled approach using microservices (Mazzara et al., 2017). In a traditional Service-Oriented Architecture (SOA) application, the entire system relied heavily on one single executable artifact that uses one programming language or framework, resulting in more complicated code bases in the system's architecture. Therefore, making a change to the system can be challenging as the system grows over time resulting in tightly coupled monolithic services with very little cohesion in coding. This is why fixing and debugging code is a complex undertaking in monolithic applications (Newman, 2015). The monolithic approach in designing systems brought several limitations to the systems. One of the main drawbacks of such architectural style is that system maintenance is a hard and complex task since a small change in one entity can affect the entire system, therefore resources cannot be allocated efficiently based on the need of each single service. There is also a possibility of a single point failure in the system (Nehme et al., 2019).

However, microservices (a more complete definition will be provided later) are implemented as independently deployable services that can perform only one specific business function, leading to less complexity in service implementations. Given the "no share" standard in microservice architecture (MSA), each service uses its own database, which helps reduce the dependency between services. There is also less chance of single point failure as each microservice operates independently.

Hence, failure in one microservice will not affect the entire system. Moreover, since MSA based applications are composed of multiple microservices, it is possible to use different technologies to meet the requirements of each microservice and avoid choosing one standardized technology, which increases the robustness of the code (Nehme et al., 2019).

However, these microservices need to collaborate with each other to complete their tasks and achieve the outcome of the application. Therefore, it is important to define a communication mechanism between microservices in one application. This mechanism is called service composition and is realized through two main composition methods: Choreography and Orchestration. Some recent studies have suggested using a combination of Choreography and Orchestration which is called a hybrid composition method. Obviously, these composition styles have pros and cons. Therefore, companies need to choose the right composition style to fit their software applications' requirements and accomplish their business needs. Yet, this remains a challenging task since every business has different standards and requirements.

In this paper, we assess the complexity of the two leading microservice composition techniques. Complexity has been used in the literature as a metric to evaluate business process models (Solichah et al., 2013), (Kluza et al., 2014; Kluza & Nalepa, 2012), (Haouari & Ghannouchi, 2017; Rolón et al., 2009). We use this metric to assess the complexity of BPMN models for the Choreography and Orchestration of microservices. These metrics are numerical expressions of the models' complexity and structure which are derived from software engineering performance metrics. They embody a quantitative measurement of the maintainability of the models as well as the ease of forecasting errors in such models (Banerjee, 2018). These metrics can help in measuring the complexity level in microservice Orchestration and Choreography to assess the models' difficulty level with regards to their understandability and maintainability.

Problem Statement

The goal of our study is to design BPMN-based microservice Orchestration and Choreography models and assess and compare their complexity. To achieve this goal, first, we define multiple e-commerce scenarios and use the two composition techniques to model, implement, and run those scenarios within a microservice architecture development environment. Then, we use various methods for measuring BPMN complexity to evaluate our models and draw conclusions. Hence, we need to answer the following research question:

Which composition technique (Orchestration or Choreography) leads to less complex models to deliver the business requirements in e-commerce applications?

Main Contributions

This study provides insights into the BPMN modeling of microservice Orchestration and Choreography in the domain of e-commerce applications. The main contribution of this study is to distinguish the differences between Choreography and Orchestration using complexity metrics, which provides a better understanding of microservice composition. BPMN modeling techniques and tools allow us to deploy and execute our models to make sure that they are following a correct logic based on real e-commerce scenarios. Note that most studies in the literature only propose BPMN modeling without any deployment or execution. Thanks to BPMN 2.0, our models provide a high-level notation of e-commerce workflows using Choreography and Orchestration, hence they can be easily understood by all stakeholders, namely managers, business analysts, and developers.

Research Methodology

We rely on the six-step process of Design Science Research (DSR) (Peffer et al., 2007). The design-science paradigm is basically aimed to suggest solutions to existing problems by using various scientific methods to analyze the structure of a system and its real-life applications (Shrestha & Vuorimaa, 2019).

The six-step process of the DSR methodology includes: (1) identify the research problem and motivation, (2) define the objective of a solution, (3) design and development, (4) demonstration, (5) evaluation, and (6) communication. Following the abovementioned steps, we first define our research problem (i.e., research question), which is comparing the level of complexity between microservice Orchestration and Choreography in the development of e-commerce applications, based on the most recent studies in the literature and real-world e-commerce scenarios in the industry. Next, we propose solutions to the problem by defining the objectives. Our objectives are focused on evaluating and comparing the level of complexity for two microservice composition techniques (Choreography and Orchestration) using BPMN 2.0 executable models in the domain of e-commerce. In the third step, we develop our e-commerce scenarios. To this end, we follow a series of steps: 1. Study e-commerce websites; 2. Identify, document, and classify e-commerce scenarios into 3 categories (small, mid-sized, end-to-end); 3. Use BPMN 2.0 to model a Choreography and an Orchestration for each scenario. In Step 4, we use Zeebe BPMN Modeler, Zeebe-docker, CAMUNDA automation engine (Zeebe.io, 2021), and Amazon Web Services-AWS cloud to design (i.e., model the workflows or microservice compositions) and deploy the microservices on the cloud. Once we have the workflows designed and deployed, we evaluate them using three tools called Zeebe Simple Monitor, Kibana Elasticsearch cluster to visualize log files, and Camunda Operate to test the instances in the workflows and execute them to make sure they run with no errors. In the second step of the evaluation, we use complexity metrics to assess and compare our models and draw insights. Finally, we use the results of our evaluation to analyze both composition techniques and use the results to discuss the impacts of complexity on the modifiability and understandability of the models.

Structure of the Paper

The remainder of this paper is structured as follows. Section 2 features the background and related work about microservice composition techniques and state of the art in complexity metrics. Section 3 presents complexity measurement approaches for business processes. Section 4 outlines the logic we proposed to model and execute microservice compositions. Section 5 focuses on the implementation and evaluation. Section 5 focuses on the results we obtain from the evaluation of our models. Finally, we use the results of the evaluation to draw conclusions and propose suggestions for future work in this area.

BACKGROUND

Research Domain

Our research domain is e-commerce applications, and there are two main reasons for that. First, given the rapid growth in information and communication technology (ICT), there has been an extensive utilization of e-commerce applications for businesses to compete in the market and grow their revenue, market share, and customer loyalty. E-commerce applications have increased significantly as a way for companies to promote their business (Asrowardi et al., 2020). Secondly, with the global pandemic of COVID-19, which hit the world in December 2019, there has been a huge transformation in the way businesses operate, e-commerce being one of the enablers of such transformation (Bhatti et al., 2020). However, as e-commerce grows there is a need for more advanced technologies such as microservices to support and give more flexibility to online shopping platforms. Given the various services involved in e-commerce applications, microservices can potentially improve such applications by offering loosely coupled microservices allowing them to deliver services to users from anywhere, anytime in an uninterrupted and dynamic fashion. Microservice concepts and tools can make a significant transformation within the e-commerce industry to allow hundreds of modules to work in parallel. Hasselbring & Steinacker (2017), for instance, address the use of microservices in one of the biggest European e-commerce platforms called Otto.de. They discuss the importance of microservice technology in the domain of e-commerce and how microservices improve scalability, reliability, and agility of the Otto.de website by using a vertical structure. Their study shows another useful feature of a microservice architecture which makes them well suited for e-commerce applications, namely high consistency. This is achieved by proposing a transaction-less communication between microservices to keep the data consistent across the system with little dependency among services on an e-commerce platform. However, this approach is not possible in a monolithic application as they use transactions to maintain consistency which causes considerable coupling in the system. Other important features of microservice composition are fault tolerance and resiliency of the system. Given the cross-functional design of microservices, each microservice works independently and failing of one microservice will not affect the entire system (Hasselbring & Steinacker, 2017).

Given the applicability and potential of microservices in the domain of e-commerce, our study is aimed to perform a model complexity-based comparison between the leading microservice composition styles (Choreography and Orchestration) in developing e-commerce applications.

In particular, we propose a manifesto of microservice composition styles by:

1. Designing BPMN models to provide a clear representation of how microservices communicate in both Choreography and Orchestration.
2. Using the designed models to execute high-level e-commerce scenarios following MSA protocols to build single tasked microservices with a high degree of decoupling.
3. Performing an analysis on the models to measure their complexity and use the results to illustrate how complexity affects the understandability and maintainability of the models.

Related Work

Microservice composition shows service collaborations, the business process, and the sequence of the activities in one application. In other words, it is used to deploy and coordinate services in a business application. As mentioned earlier, there are two well-known composition techniques that are used in microservice applications, Choreography and Orchestration. Below we provide a brief overview of each composition technique.

Orchestration

In Orchestration, all microservice interactions are controlled by a central controller that functions similar to an orchestrator (Rudrabhatla 2018). The Orchestrator is responsible for the entire communication in the system. The central controller manages all the requests and service calls. This centralized environment uses request/response messages as a communication mechanism. The central controller calls a service by sending a request to that microservice and waits for it to respond before sending a request to the next microservice (Rudrabhatla, 2018). The next microservice cannot be called until the called microservice sends the proper response to the Orchestrator. This increases the waiting time and dependency between microservices (Valderas, 2020).

Choreography

In Choreography, there is no central controller, so microservices work independently. The output of a microservice is the input of another microservice. This approach uses an event-driven architecture pattern for microservices which makes this approach relatively complex compared to Orchestration (Baškarada et al., 2018; Isoyama et al., 2012; Rudrabhatla, 2018). In this technique, each microservice performs its own task and communicates with other services to complete complex tasks and get the right result.

According to (Cerny et al., 2018, p. 46), “Choreography allows each involved party to describe its part in the interaction. Choreography tracks the message sequences among multiple parties and sources rather than a specific business process that a single party executes”.

A Comparison of Choreography and Orchestration

Microservice composition captures service collaborations, the business process, and the sequence of activities in one application. In other words, it is mainly used to deploy and coordinate services in an application. In this subsection, we use the literature to evaluate the advantages and disadvantages of microservice choreography and orchestration (see Table 1).

In an event-based choreography style, when a microservice performs a transaction, it creates an event that can be used by other microservices in the application to initiate their local transactions. This process continues until all the services publish their events. The process ends when there are no more events to be broadcasted (Isoyama et al., 2012; Kluza & Nalepa, 2012). There is no central controller in this composition technique to listen to the transactions and call the right microservice to execute the transaction.

The other composition style is orchestration in which there is a coordinator that listens to the events published by any of the microservices' local transactions and assigns the next task (transaction) to the right microservice based on the incoming event. The performance of an event-based choreography is quicker than orchestration. Therefore, it is a suitable option for applications with limited number of microservice calls where time is an important element. While timing is relatively higher in the orchestration method, this technique reduces the complexity of error tracking in the system considerably thanks to the presence of a central orchestrator at a single location (Kluza & Nalepa, 2012).

Table 1: Choreography Vs. Orchestration

Features	Orchestration	Choreography	References
Monitoring	✓ Easier thanks to the central conductor	✓ No monitoring, as microservices are responsible for their performance	(Cerny et al., 2018)
Error fixing	✓ Easier to detect errors as all the tasks are constantly monitored by the orchestrator	✓ Hard to detect errors but errors cannot affect the entire system	(Nkomo & Coetzee, 2019)
Scalability	✓ Offers low scalability as it is hard to add a new service	✓ Offers a high level of scalability since all services work independently and a new service can be added more easily	(Cerny et al., 2018)
Speed	✓ More latency due to send/request communication technique	✓ No or very little latency due to event-based communication	(Kluza et al., 2014; Kluza & Nalepa, 2012)
Complexity	✓ Less complex and easier to manage as there is a central controller to assign tasks and handle the communication in the entire system	✓ More complex since a developer in charge of one microservice has no access to what is happening (i.e., the inner workings) in other microservices	(Conte, S.D., Dunsmore, H.E., Shen, 1986; Isoyama et al., 2012; Kluza et al., 2014; Kluza & Nalepa, 2012; Peltz, 2003)
Dependency	✓ More coupling	✓ No coupling or loosely coupling	(Conte, S.D., Dunsmore, H.E., Shen, 1986; Kluza et al., 2014; Nkomo & Coetzee, 2019)

State of the Art in Complexity Metrics

There have been many studies on measuring and evaluating the quality of software products using different metrics. Nkomo and Coetzee (2019) defined five design principles that can be used to measure the quality of software design. These principles include:

- 1- Coupling: describes the interconnections among the modules.
- 2- Cohesion: describes the relationships between the elements of a module.
- 3- Complexity: describes the number and size of the control constructs.
- 4- Modularity: describes how modular the system is, in other words, whether the components of the system can be separated and put back together via logical partitioning.
- 5- Size: describes the entire dimension of the software product.

Among these five principles, complexity has been the focus of many studies in the domain of software engineering. According to (Kluza et al., 2014, p. 6), "IEEE Standard Computer Dictionary defines complexity as the degree to which a system or component has a design or implementation that is difficult to understand and verify".

Similarities Between Metrics in Software Engineering and Business Process Modeling

Software engineering metrics have been used to evaluate different features of software products such as error prediction (Conte, S.D., Dunsmore, H.E., Shen, 1986), measuring the quality of software processes (Wang et al., 2011), measuring software functional size (Rolón et al., 2006), and quality metrics in software design (Monsalve et al., 2011). Companies use these metrics to measure the performance of their software products.

Business processes are another important element in the lifecycle of a software product as they are used from the early stages of a software development project by both software engineers and business analysts to document and gather system requirements (Rolón et al., 2006). Hence, several studies have focused on finding similarities between software and business process. Table 2 compares the similarities between software and business process based on the modules, elements and compositional structure used in both domains (Monsalve et al., 2011).

Table 2: Similarities between software and business processes (Monsalve et al., 2011)

Software	Business Process
Module/Class	Activity
Method/Function	Operation
Variable/Constant	Data element

According to Table 2, there are similarities between software programs and business process models, regardless of the modeling language being used (e.g., BPEL, EPC or BPMN). A software program is divided into modules or functions, which perform by obtaining some inputs and providing some outputs. Similarly, business process models use activities. Hence, the order by which an activity is executed in a process model is predefined using operators such as sequence, splits and joins, which is similar to how the modules and functions interact in a software program (Monsalve et al., 2011).

Complexity Metrics Measurements Approaches

Business processes cannot be measured by only one single metric. Therefore, many studies suggest different measurement metrics for business processes, which are inspired by the ones used in software engineering. The state-of-the-art on complexity metrics in business process modeling is summarized in Table 3.

Table 3: State of the art on complexity metrics in BPM

Metric	Reference
Lines of Code (LOC): Counts the number of lines of code in software programs. Cardoso et al. (2006), use LOC to adapt three size metrics for BPM (J Cardoso et al., 2006): <ol style="list-style-type: none"> 1- NOA = Number of Activities in a workflow 2- NOAC = Number of Activities and Control-flow in a workflow 3- NOAJS = Number of Activities, Joins, and Splits 	(Jorge Cardoso, 2005)
Control-Flow Complexity metrics (CFC): This metric is measured based on XOR-splits, OR-splits, and AND-splits in one process.	(J Cardoso et al., 2006; Jorge Cardoso, 2005)
McCabe's cyclomatic complexity metric (MCC): This is a graph-theoretic technique that calculates the cyclomatic number of a graph by counting the maximum number of linearly independent paths in the graph.	(Banerjee, 2018; Jorge Cardoso, 2005)
Durfee square metric (DSM) and perfect square metric (PSM) <ul style="list-style-type: none"> • DSM: Equals d if there are d types of elements which occur at least d times in the model (each), and the other types occur no more than d 	(Kluza et al., 2014; Kluza & Nalepa, 2012)

<p>times (each).</p> <ul style="list-style-type: none"> • PSM: Is the (unique) largest number such that the top p types occur (together) at least p^2 times, given a set of element types ranked in decreasing order of the number of their instances. 	
Information flow metrics by Henry and Kafura: This approach focuses on evaluating the procedure complexity (PC) based on the frequency of calls in and out of the modules in one system	(Banerjee, 2018; Solichah et al., 2013; Vanderfeesten et al., 2007)
The coefficient of network complexity metric (CNC): This metric is used to measure the complexity of a model based on the number of nodes and arcs involved in the process.	(Banerjee, 2018; Kaimann, 1974; McCabe, 1976; Sánchez-González et al., 2010)
Connectivity level between activities (CLA): This is measured by counting the total number of activities (TNA) divided by the total number of sequence flows between activities	(Banerjee, 2018; Wang et al., 2011)
Halstead-based process complexity: This measures the complexity of business process models by using four measures (n_1 , n_2 , N_1 , and N_2) to evaluate process length; process volume; and process difficulty. <ul style="list-style-type: none"> • n_1= The number of activities, joins, splits, and other control flow elements in a BP • n_2= The number of data containers used by the process and activities • N_1=The total number for the frequency of type n_1 • N_2= The total number for data containers (n_2) 	(Banerjee, 2018; Latva-Koivisto, 2001; Solichah et al., 2013)
Structural metrics: These metrics measure the level of understandability and error-probability in a model using multiple square metrics.	(Fitzsimmons and Love, 1978)

MICROSERVICE ORCHESTRATION and CHOREOGRAPHY MODELING

In this section we discuss the modeling of e-commerce scenarios using Zeebe Modeler BPMN 2.0 and Zeebe Simple Monitor (Zeebe.io, 2021). Each model depicts a single e-commerce scenario (i.e., workflow). We compose each workflow using both composition styles (i.e., Orchestration and Choreography), which rely on different communication mechanisms. For Orchestration, we use the Intermediate message catch event which relies on a send/receive message approach managed by the orchestrator to call each microservice and should wait for a response from the microservice to be able to call the next microservice. For Choreography, we implement event Choreography which uses microservice calls as events. This way microservices work independently without depending on calling other services.

Define Scenarios

We classify multiple scenarios based on different shopping processes on e-commerce websites. To this end, we follow a series of steps: 1. Study e-commerce websites; 2. Identify, document, and classify e-commerce scenarios into 3 categories, namely small, mid-sized, and end-to-end; 3. Use BPMN 2.0 to model Choreography and Orchestration for each scenario from the 3 categories. We will use these categories later to evaluate the impact of the size of the models on their level of complexity.

Design BPMN Models

We use Zeebe BPMN Modeler, Zeebe-docker, CAMUNDA automation engine (Zeebe.io, 2021), and Amazon Web Services-AWS cloud to model the microservice compositions and deploy the microservices on the cloud. We do this for all the scenarios we selected

earlier. In our development process, we follow the BPMN 2.0 modelling guidelines (Zeebe.io, 2021) to model our workflows into microservice Choreographies and Orchestrations, representing the communication mechanisms among microservices and characteristics of each composition style.

Small-sized BPMN Workflows

In this section, we design BPMN models to capture the Choreography and Orchestration of microservices. Each model illustrates one single e-commerce module which uses one or group of microservices to perform a single task for an e-commerce application. These modules are user authentication, shipment, and payment.

User Authentication

This service is used to authenticate users on the e-commerce website. If the user is already registered, then the system redirects them to a login page where they can enter their login credentials. If the user is new, they are given the choice to either proceed as a guest or register on the website. Figure 1 shows the Choreography workflow for user authentication designed in Zeebe modeler. We define a variable called "userId" with two values Yes/No, which we use in the execution of the workflow. Upon creating a new instance on Zeebe Simple Monitor, the first task is called (Browse site), next we move to the XOR gateway to choose between the alternatives. For that we should call the userId variable and give it a value based on the scenario we are

replicating. In our execution, we choose Yes for the XOR gateway, and this triggers the login task to complete the process. In this scenario, four microservices are involved: browse site, login, sign up, and proceed as a guest.

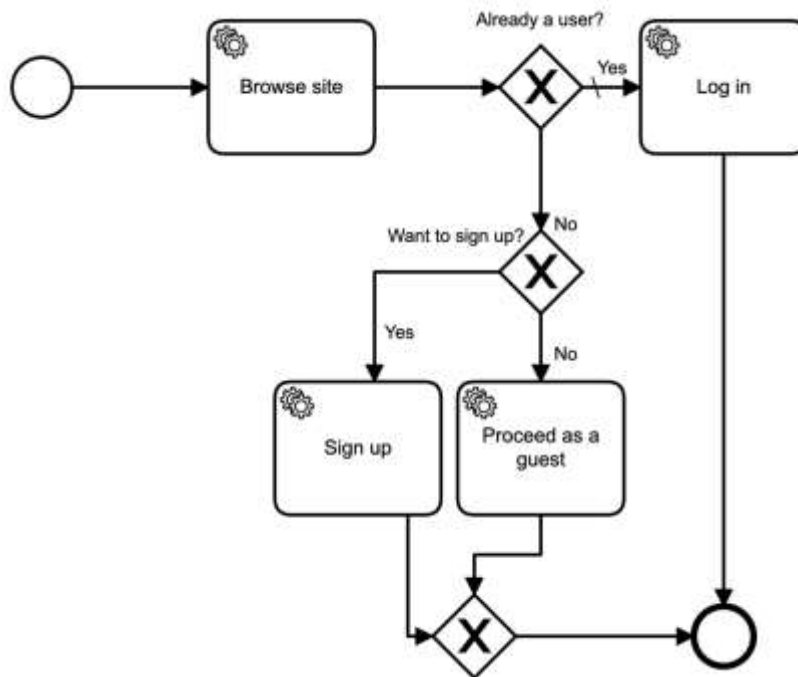


Figure 1: Choreography model for user authentication workflow

The second workflow, as shown in Figure 2, uses Orchestration to model the same scenario. To implement Orchestration for this workflow, we have defined a microservice task called e-commerce, which acts as the orchestrator. In order to deploy and execute the workflow on Zeebe Simple Monitor (Zeebe.io, 2021), we need to define an automated logic to call the next microservice task in the process without having to develop any code. Hence, we have defined a variable called serviceCall which the orchestrator will use to call the next microservice in the process by giving it a predefined value. We use the name of each microservice task as the values for our defined variable to call that service. All the communications between services are mapped using the Message Intermediate Catch Event, which is a BPMN 2.0 message event. In this scenario there are six microservices involved: browse site, e-commerce (the Orchestrator), user authentication, login, sign up, and proceed as a guest.

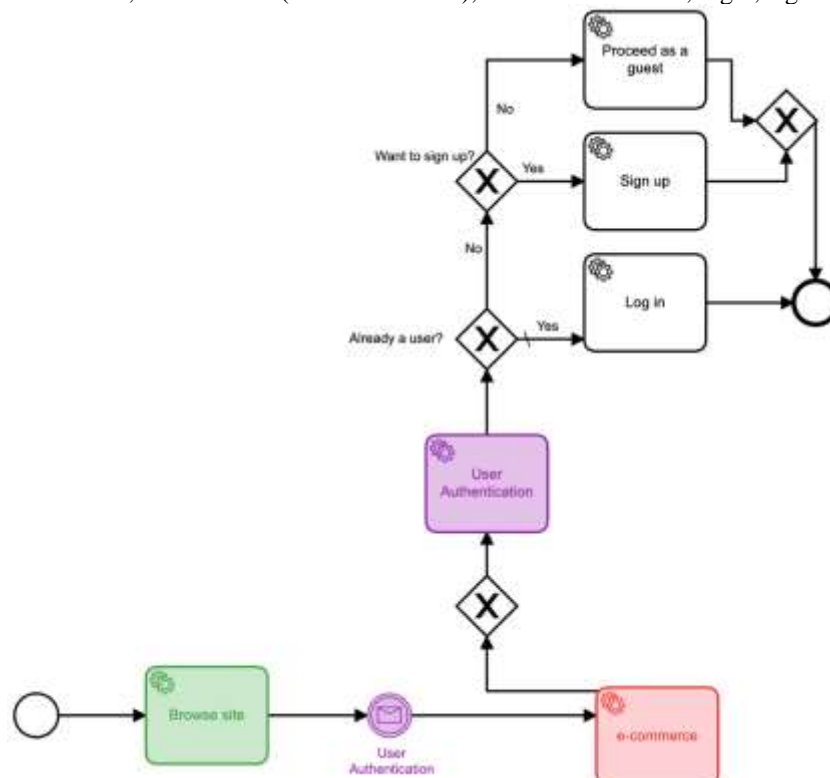


Figure 2: Orchestration model for user authentication workflow

Shipment

In this scenario the user should choose between two delivery methods: ship to address or pick up at store. The store pickup (also known as curbside pickup) is a relatively new feature and has been popular recently due to the current pandemic which has affected the way businesses operate. One more feature that we add to this scenario is the shipping fee option, which is based on the total order value. For orders above \$100 users will not be charged any shipping fees. To implement, this we use a feature on Zeebe Modeler to add a condition on the sequence flow. To that end, we define a variable called “orderValue” and add the following condition “=orderValue>=100” to the sequence flow which is linked to the shipping fee service task. For both XOR gateways we have defined variables and values of Yes/No. Figure 3 shows the shipment workflow as a Choreography.

In this scenario there are six microservices involved: select delivery method, ship to my address, pick up at store, select the nearest store, add shipping fees, ship for free.

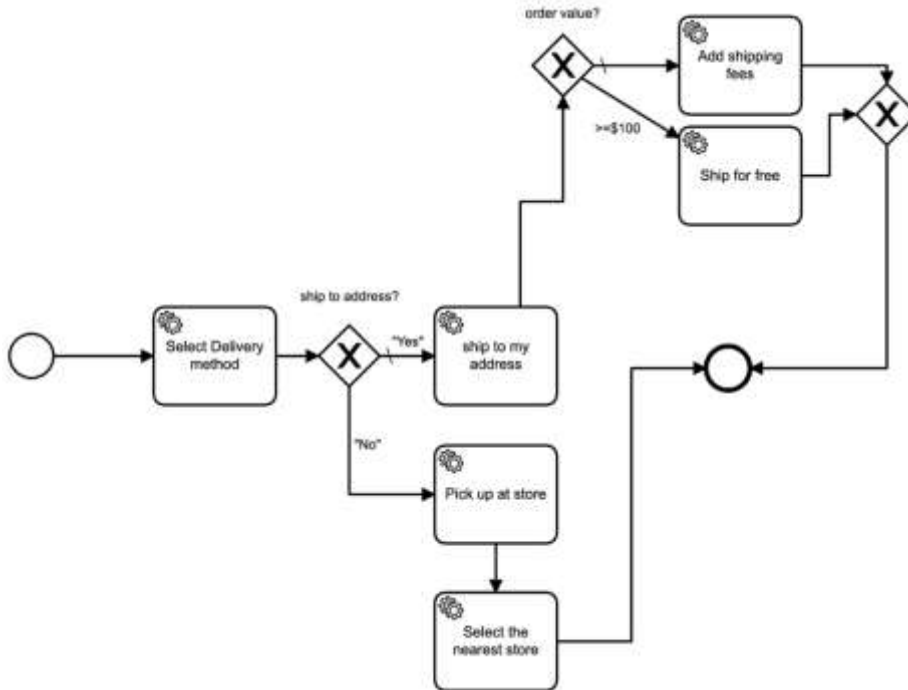


Figure 3: Choreography model for shipment workflow

The shipment workflow modeled as an Orchestration is shown in Figure 4. In this scenario there are eight microservices involved: e-commerce (Orchestrator), shipment, select delivery method, ship to my address, pick up at store, select the nearest store, add shipping fees, ship for free.

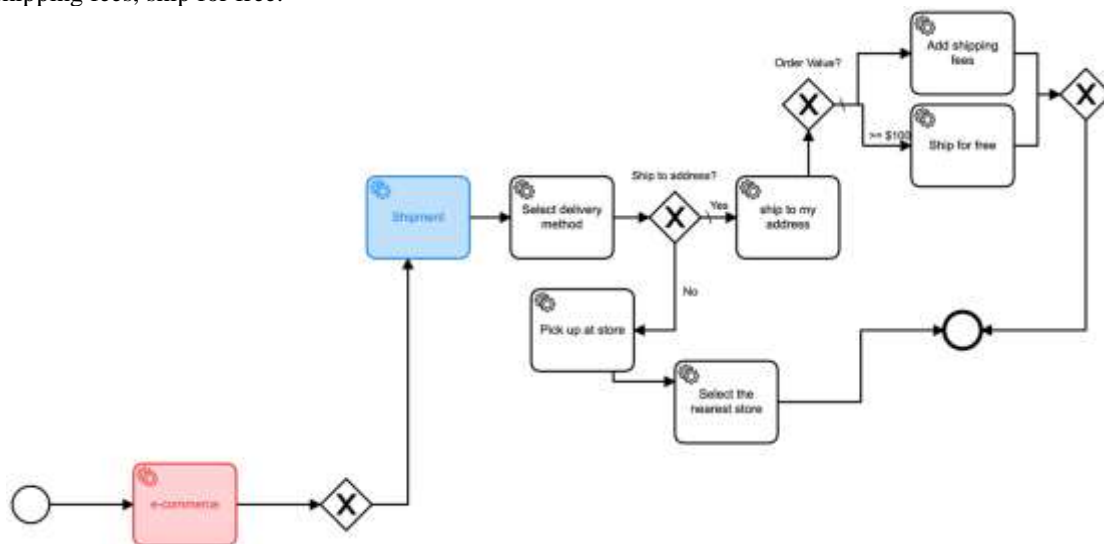


Figure 4: Orchestration model for shipment workflow

Payment

This service allows users to make payments online using debit or credit. Some websites support another payment method called cash-on-delivery, which enables users to pay for their orders after they receive the items. Figure 5 shows the designed Choreography model for the shipment workflow using Zeebe Modeler. We have defined a variable called “paymentId” with two values Yes/No, which we use in the execution of the workflow. Upon creating a new

instance on Zeebe Simple Monitor, the payment service task is called to initiate the payment. We use an XOR gateway to check if the payment has been successfully processed using the predefined variable. In this scenario there are two microservices involved: initiate payment and choose payment method.

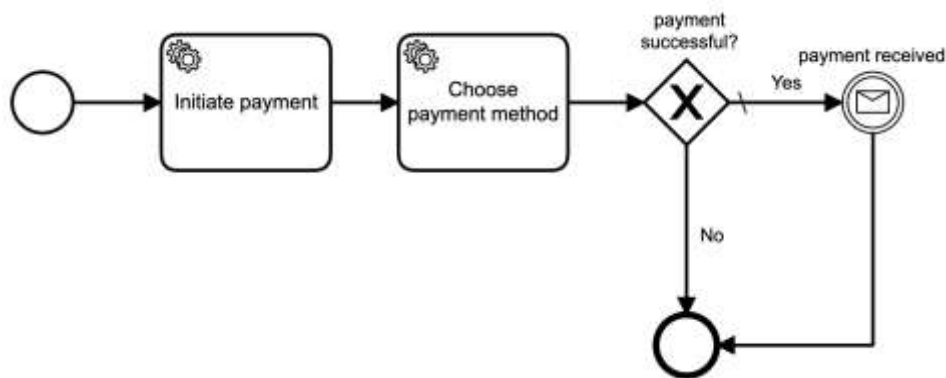


Figure 5: Choreography model for payment workflow

The payment workflow modeled as an Orchestration is shown in Figure 6. As mentioned above, e-commerce is the central controller in this process. In this scenario there are three microservices involved: e-commerce (Orchestrator), initiate payment, choose payment method.

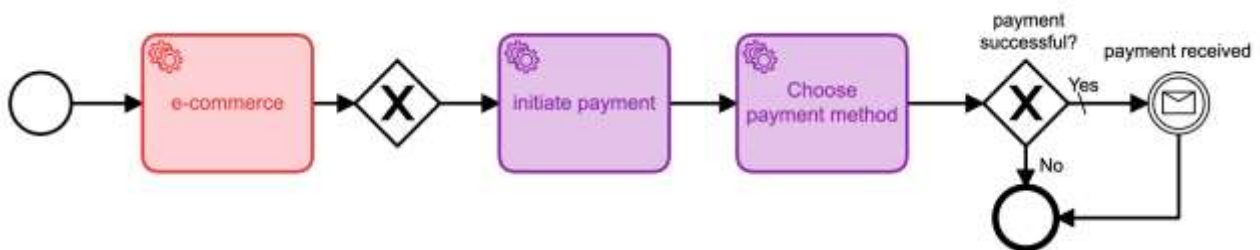


Figure 6: Orchestration model for payment workflow

Mid-sized Workflow

In this section, we combine the workflows described above to design a new set of models, which include more than one microservice in their process to perform the user authentication and shipment modules of an e-commerce application as part of the checkout process, Figure 7 and Figure 8. We use the same tools for the design, deployment, and execution of the models (Zeebe.io, 2021).

User Authentication + Shipment

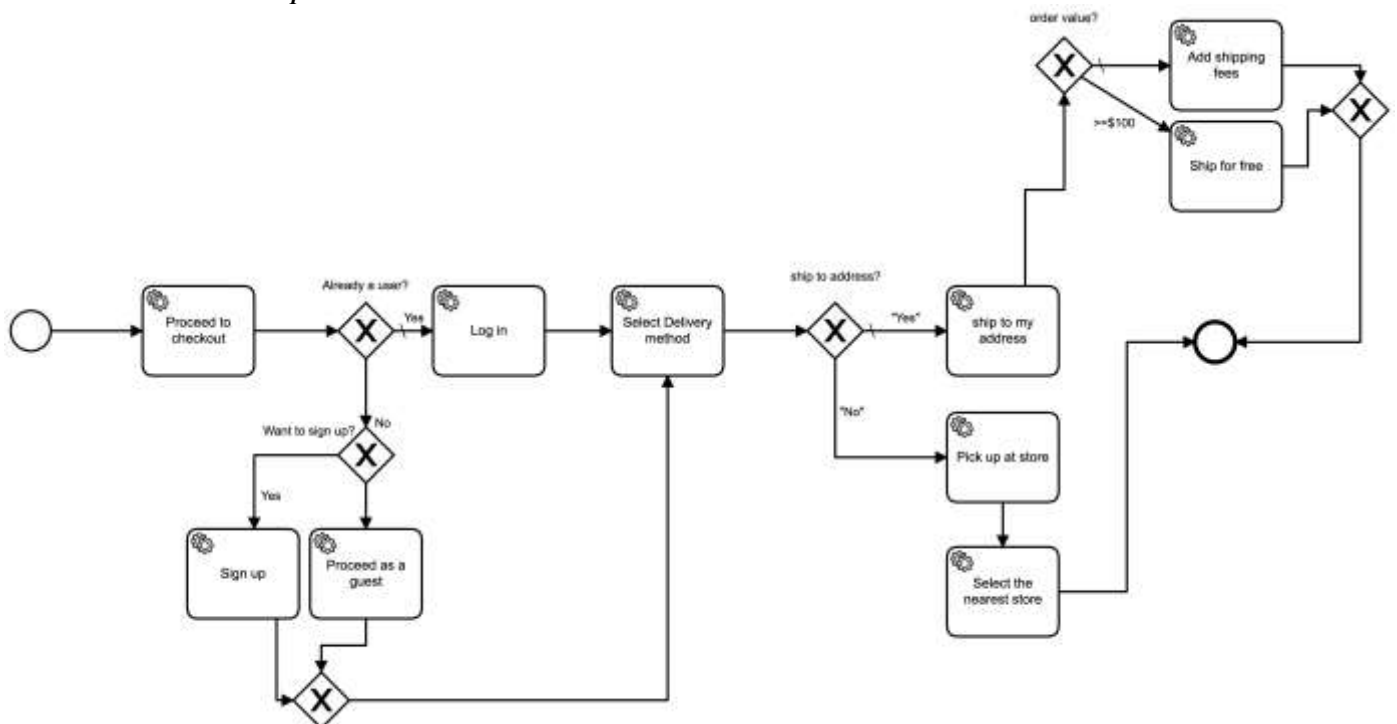


Figure 7: Choreography model for user authentication +shipment workflow

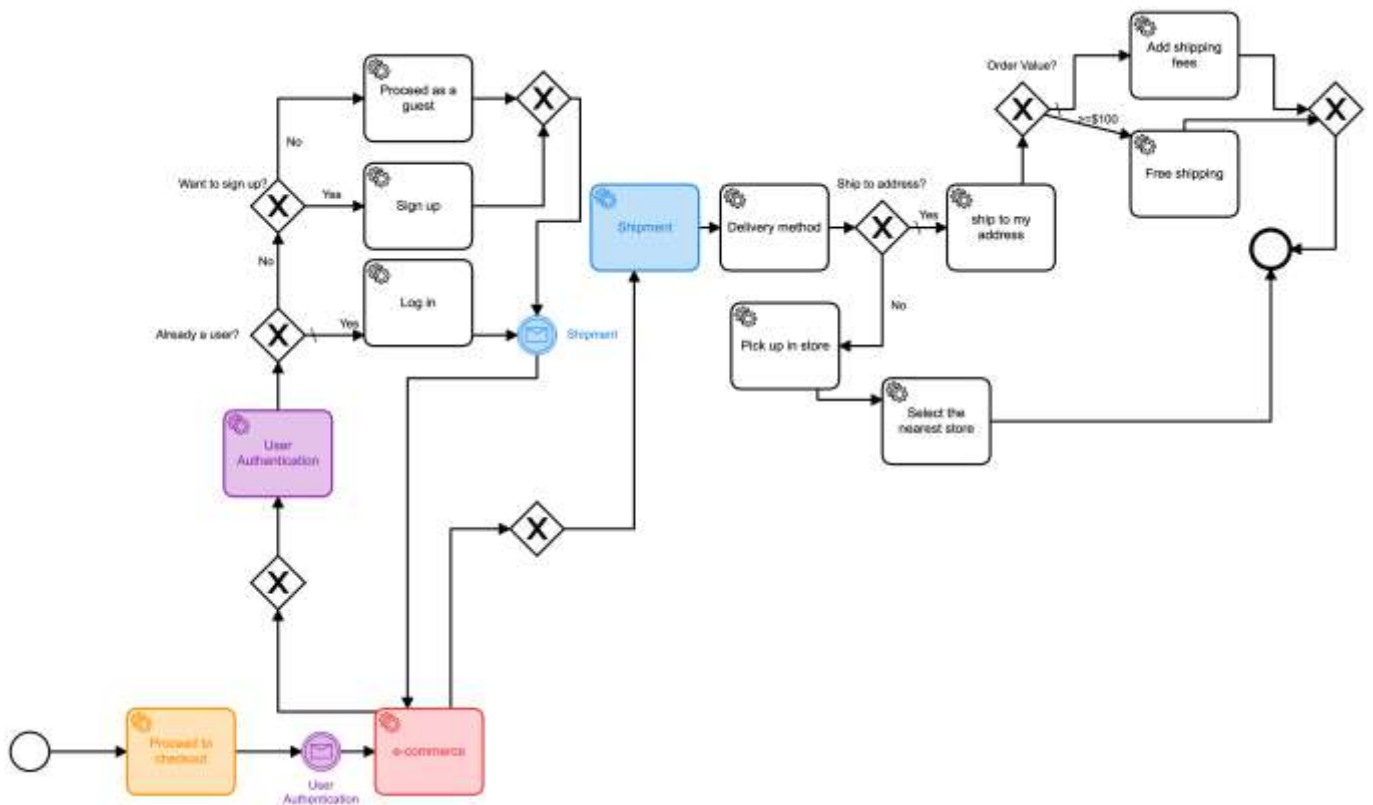


Figure 8: Orchestration model for user authentication + shipment workflow

End-To-End Workflow

We designed an end-to-end workflow for an e-commerce application from when a user starts browsing on the website until the order is delivered. We use the same modeling technique and tools to design the Choreography and Orchestration in Figure 9 and Figure 10 to illustrate a full lifecycle of an e-commerce application.

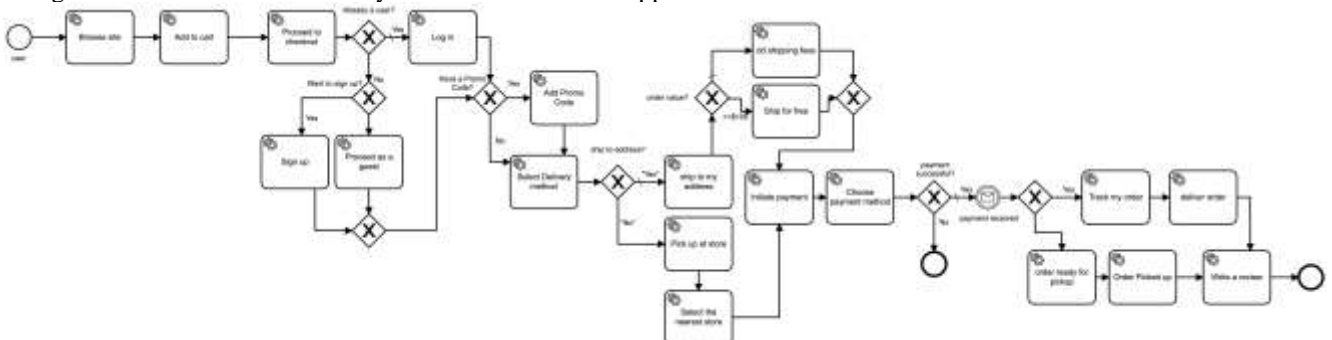


Figure 9: Choreography model for end-to-end workflow

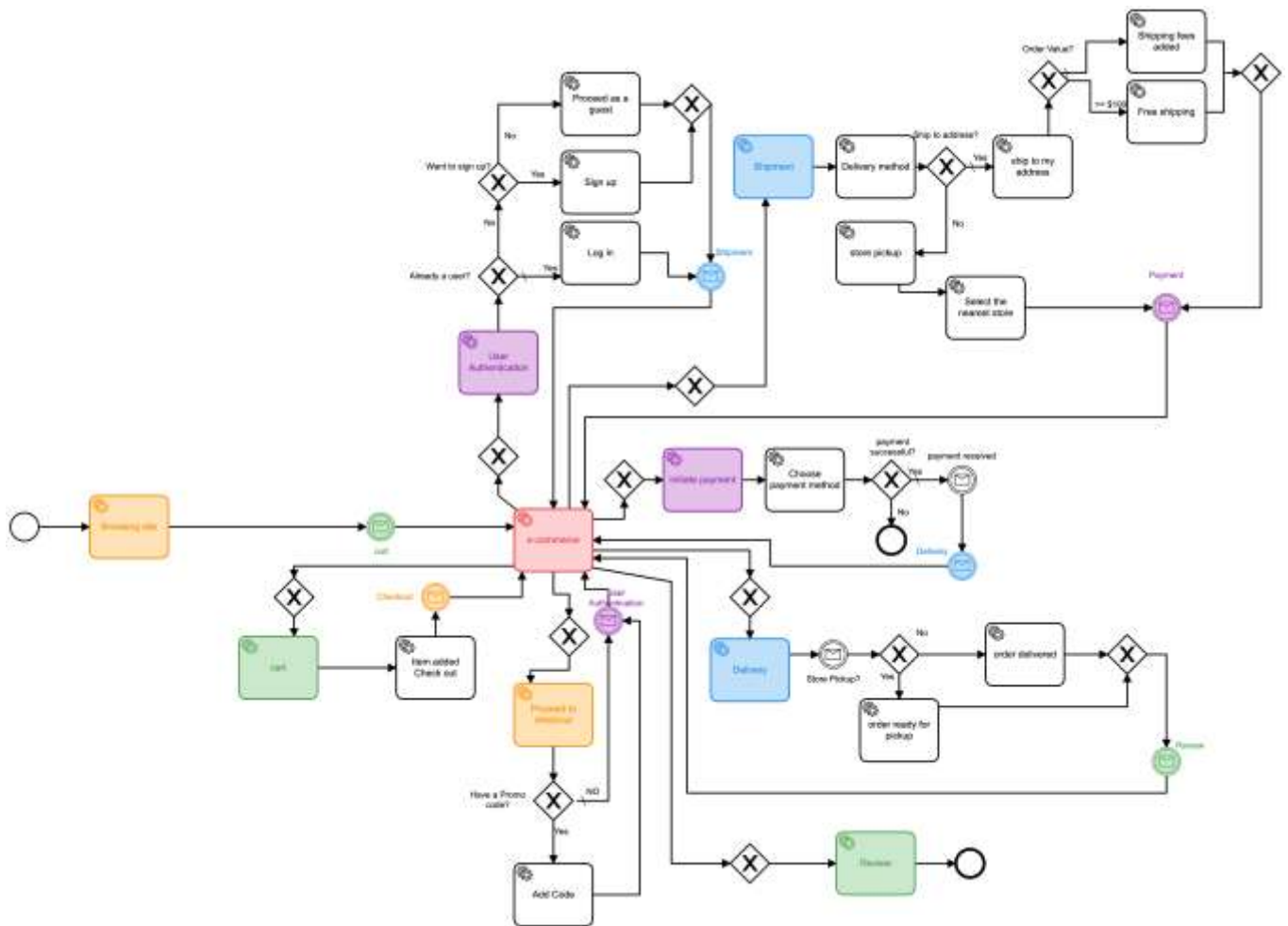


Figure 10: Orchestration model for end-to-end workflow

IMPLEMENTATION & EVALUATION

In this section, we first present the approach and tools we use to deploy the resulting models for both Choreography and Orchestration and create and execute instances of each model following the guidelines provided in (Zeebe.io, 2021). Next, we use the metrics from Section 3 to assess the complexity of each workflow.

Implementation Tools

We use Zeebe Modeler to design our BPMN models, and Camunda Workflow to deploy those models on a platform called Zeebe Simple Monitor. This platform gives access to a consistent environment to deploy and run BPMN models, using AWS cloud as the server, which we use to upload and execute our models to test if there are any errors with the workflows (Zeebe.io, 2021). If there is anything wrong in the design of the workflow, the deployment fails. All the workflows proposed in this research have been tested and have been successfully deployed.

Evaluation of Complexity

In this section we describe how we apply the complexity metrics discussed in Section 3 to measure the complexity of our models. BPMN is used to capture business process flows using flowchart-based steps. BPMN consists of four groups of elements for modeling, which are Flow objects, Connecting objects, Swimlanes, and Artifacts.

- Flow Objects: Include activities, events, and gateways
- Connecting Objects: Include sequence flow, message flow, and association
- Swimlanes: Include lanes and pools to separate activities into different units
- Artifacts: Include data objects, group, and annotation

All the above-mentioned elements can be used when modeling BPMN workflows, however, based on the modeling logic that is being implemented, some of the elements may not serve the purpose of the designed models. This modeling logic can be affected by various factors, including the domain of the business, the modeling tool, and the technology, which might impact the modeling patterns and results considering what measurement technique is being used.

In our research, we focus on e-commerce as our domain, using Zeebe Modeler as the main modeling tool and microservices as the technology to design BPMN models. Hence, given the logic we use for our designed workflows, not all the metrics are applicable to be used on our models, as some of them require elements of BPMN that we do not use in designing our models. For instance, the Halstead-based process complexity uses data containers as one of its four measures, but there are no data containers in our models, since we are not focusing on the data model design and data sharing architecture of microservices. Hence, this metric cannot be used for our evaluation.

In the following, we use the shipment workflow (see Figure 3 and Figure 4) as our sample model to explain how we apply the complexity metrics discussed in the previous chapter and compare the level of complexity between them. After that, we apply the metrics to the remaining models to measure their complexity.

Lines of Code Metric

The lines of code metric can be used to measure the complexity of a process. Zeebe modeler generates XML code for each BPMN model. For the Shipment workflow, the total number of lines of code for the Choreography workflow is 194, while the same workflow modeled as an Orchestration generates 244 lines of code.

Size Metrics

We apply the three size metrics proposed in (Vanderfeesten et al., 2007) from Section 2.5 to the Shipment workflow and the results are shown in Table 4.

Table 4: The size metrics for Choreography and Orchestration

Choreography	NOA= 6
	NOAC= 18
	NOAJS= 9
Orchestration	NOA= 8
	NOAC= 21
	NOAJS= 12

Control-Flow Complexity Metrics (CFC)

We apply the CFC metric to the Choreography and Orchestration of the Shipment workflow. There is only one kind of gateway (XOR) used in the models, therefore the CFC for each workflow equals the total number of $\sqrt{CFC_{XOR}}$. As evident from Figure 3, in the Choreography workflow, there are 5 outgoing arcs in total, so the CFC equals 5. And according to Figure 4, for Orchestration the CFC equals 6, which shows a higher level of complexity in Orchestration.

Durfee Square Metric (DSM) and Perfect Square Metric (PSM)

DSM refers to the least number of elements that is used in a workflow. Hence, to measure the DSM metric we list all the elements used in each shipment workflow with the number of times they occurred to find the element with the least frequency. As shown in Table 5, the DSM for Choreography is lower than Orchestration which depicts that there is more complexity in Orchestration as the result of this measurement.

Table 5: Element types and their frequency in Choreography and Orchestration workflow

Element types	Frequency	
	Choreography	Orchestration
Service Tasks	6	8
XOR Gateway	3	4
DSM	DSM=3	DSM=4

For PSM, we perform the computations by giving an assumed value to p, based on the occurrence of each element in the workflow. We start with p=1, which counts the frequency of the first element in the workflow, we add up to the value of p and count the combined occurrence of the elements for as long as the total satisfies the boundary condition of p times. For Choreography, if we assume p to be 4, the combined occurrence for the elements is 11 which fails to satisfy the boundary condition of at least 16, therefore the PSM equals 3. We perform the same measurement for Orchestration, and we get the same result for PSM, which equals 3.

Coefficient of Network Complexity Metrics

CNC measures the complexity of the workflow by counting the total number of arcs relative to the count of other elements in the workflow. We apply this metric to the workflows in Figure 3 and Figure 4 and the results are shown below in Table 5. For the Choreography model, the total number of arcs (sequence flows) equals 12 divided by the total counts of all other entities, which includes service tasks, OR gateways, start and end events. For the Orchestration the total number of arcs is 16 divided by 14. As the numbers show in Table 6, Orchestration has a higher level of complexity compared to Choreography.

Table 6: The Coefficient of Network Complexity metric

CNC	Choreography	$\frac{12}{11} = 1.09$
	Orchestration	$\frac{16}{14} = 1.14$

Structural Metrics

Structural metrics are inspired by the Coefficient of Connectivity (CoC) metric and focus on measuring the Diameter in a workflow. Hence, in this section we measure the Diameter value for both Orchestration and Choreography as described in section 2. As shown in Figure 3, the Diameter for Choreography is 7 while the Diameter measured for Orchestration (Figure 4) equals 10. Therefore, our Orchestration workflow has a higher Diameter, which means the workflow has a lower level of understandability and is more error-prone compared to the Choreography model (Fitzsimmons and Love, 1978).

RESULTS

We applied all the above-mentioned metrics on all our designed workflows, and we summarised the results in Table 7 for both Choreography and Orchestration. As evident from the results, all the metrics, except for CNC, show a higher level of complexity in Orchestration processes compared to Choreography. For instance, when we observe the results from the CFC metric, we notice that the level of complexity of Orchestration is greater than the Choreography and as the size of the model gets bigger the level of complexity increases so we see more difference in the numbers of the level of complexity of the end-to-end Orchestration model compared to the End-to-end Choreography model. The same is true for the number of activities involved in each composition technique, so from the modeling experience we also realized that there are more activities involved in Orchestration type workflows which makes the modeling process longer and more complex.

The results from the measurement of the Diameter also prove a higher level of complexity in Orchestration compared to Choreography.

The results from the CNC metric show more complexity in Choreography of small-sized models compared to Orchestration, whereas in bigger models with two or more services involved (mid-sized and end-to-end) the measurements depict a higher level of complexity in Orchestration. So overall, our results show a higher level of complexity in Orchestration than Choreography.

Table 7: Comparison of the complexity metric results for Choreography and Orchestration

BPMN Complexity Metrics	Scenario	Choreography	Orchestration
CNC= Number of arcs/ Number of activities, joins, splits	User Authentication	1.11	1.07
	Shipment	1.09	1.07
	payment	1	1
	User Authentication +Shipment	1.16	1.20
	Shipment+ Payment	1.10	1.12
	End-to-end	1.16	1.21
CFC= CFCXOR-split (A) = fan-out(A)	User Authentication	5	6
	Shipment	5	6
	payment	2	3
	User Authentication +Shipment	8	12
	Shipment+ Payment	9	11
	End-to-end	16	24
Lines of code	User Authentication	164	230
	Shipment	194	243
	payment	108	137
	User Authentication +Shipment	330	455
	Shipment+ Payment	364	493
	End-to-end	613	999
Number of activities	User Authentication	4	6
	Shipment	6	8
	payment	2	3
	User Authentication +Shipment	10	13
	Shipment+ Payment	11	12
	End-to-end	20	23
	User Authentication	6	10
	Shipment	7	10

Diameter	payment	4	6
	User Authentication +Shipment	11	20
	Shipment+ Payment	14	20
	End-to-end	22	49
DSM/PSM	User Authentication	DSM=1 PSM=2	DSM=1 PSM=3
	Shipment	DSM=3 PSM=3	DSM=4 PSM=3
	payment	DSM=1 PSM=1	DSM=1 PSM=1
	User Authentication +Shipment	DSM=1 PSM=4	DSM=2 PSM=4
	Shipment+ Payment	DSM=1 PSM=4	DSM=3 PSM=4
	End-to-end	DSM=1 PSM=5	DSM=8 PSM=5

CONCLUSION & FUTURE WORK

Conclusion

To conduct this research, we performed a thorough study of the literature to identify the main concepts related to service-oriented architecture, microservice architecture, Choreography, Orchestration, BPMN modeling in the domain of e-commerce, and the applications of complexity metrics on BPMN Choreography and Orchestration models. Firstly, we uncovered the differences between microservice Orchestration and Choreography. Secondly, we measured the level of complexity in BPMN-based Choreography and Orchestration workflows using complexity metrics from the literature. These complexity metrics helped us get a good understanding of the structure and complexity of microservices Choreography and Orchestration from a modeling perspective.

Through the findings from the literature, we were able to clarify and uncover several concepts related to microservice compositions and BPMN modeling that we used to answer our research question announced in Section 1 as follows:

- Which composition technique (Orchestration or Choreography) is less complex to deliver business requirements in e-commerce applications based on the proposed scenarios? The results from the complexity measurements we applied on our models suggest that Orchestration is more complex than Choreography for e-commerce applications because there are more services involved in modeling Orchestration compared to Choreography. We also discussed how complexity can affect the modifiability and understandability of each composition style, which makes Choreography models more modifiable and understandable compared to Orchestration.

Contributions

This study provides insights into the BPMN modeling of microservice Orchestration versus Choreography in the domain of e-commerce. The main contribution of this study is to distinguish the differences between Choreography and Orchestration using complexity as a metric, which provides a better understanding of microservice composition. BPMN modeling techniques and tools allow us to deploy and execute our models to make sure that they are following a correct logic based on real e-commerce processes. While most studies in the literature only propose BPMN modeling without any deployment, thanks to BPMN 2.0, our models provide a high-level notation of e-commerce workflows using Choreography and Orchestration. Thus, our models and results can be easily understood by all business users, namely managers, business analysts, and developers.

Research Strength

Our study is aimed to showcase the composition of microservices on real world e-commerce workflows. The key component of this research is the deployment and execution of our workflows using Zeebe Simple Monitor, as suggested by Zeebe.io (Zeebe.io, 2021). The tool enables us to test the applicability of our models to real-world e-commerce workflows without the need to write any code. Another important element of our study is that we have incorporated a communication logic for our models, which focuses on synchronous and asynchronous communication mechanisms between microservices via using conditional sequence flows and XOR gateways offered by Zeebe Modeler BPMN 2.0 in our workflows.

Limitations

Business processes can be modeled using different modelling techniques and tools. However, for our research we only rely on Zeebe Modeler to develop workflows following the BPMN 2.0 standard, which we consider a limitation of this study. We believe the results may vary depending on what modeling technique and tool is used. The second limitation of this study is that there are some complexity metrics that we could not use for our measurements, as they require the use of specific BPMN components such as processes and sub-processes. Hence, our use of various complexity metrics is limited to the modeling logic and components used in the workflows. It is important to mention that our research considers complexity as the only metric for comparison, however, based on the literature there are other metrics that can be taken into consideration to evaluate and compare microservice compositions.

One other limitation of this research is that all the proposed models are designed based on the scenarios that use in-house service integration instead of third-party services. Therefore, the results can be different when third-party services are integrated in the modeling of the workflows.

Considering the existing limitations, further research can be done to measure the complexity of microservice compositions using other modeling tools and techniques and compare the results with the existing results to get better insights on the complexity level of Choreography and Orchestration.

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Modeling IoT enablers for humanitarian supply chains coordination

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ABSTRACT

Disaster relief operations rely on reliable real-time information sharing during disasters to coordinate scarce resources and save lives. The Internet of Things (IoT) has recently been regarded as an important technology for enhancing information sharing in disaster response operations to achieve effective coordination, accurate situational awareness, and comprehensive visibility of operational resources. Despite its relevance, its adaptation and implementation have been fraught with complexity. This research aims to understand the IoT enablers of humanitarian supply chain coordination. Seven dimensional enablers have been formulated by reviewing the literature and validating with practitioners' opinions. A structural model is then developed using the Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique that addresses the interdependencies of IoT enablers in humanitarian supply chain coordination. Finding provides insights into the interplay between management support, IT infrastructures, and third-party logistics service providers as key enablers towards adaptation and implementation of IoT in humanitarian supply chains. Results provide important implications and insight to decision-makers in international humanitarian organizations toward adaptation and implementation of IoT systems in humanitarian supply chains.

Keywords: Humanitarian Supply Chain, Internet of Things (IoT), Coordination, Enablers, DEMATEL

INTRODUCTION

Natural and man-made catastrophes have both become more common in recent decades (Banomyong et al., 2019). According to the latest projections, man-made and natural catastrophes are expected to rise fivefold in incidence and intensity over the next 50 years (Agarwal et al., 2019; Chen et al., 2020). Recent catastrophes have highlighted the importance of humanitarian supply chain management (HSCM) in meeting beneficiaries' demands and ensuring effective long-term recovery following disasters. According to Thomas and Kopczak (2005), humanitarian supply chains entail "the process of implementing, planning, and controlling an efficient flow and cost-effective storage of information, goods, and materials and from the point of origin to the end of the affected area, to alleviate the suffering of the affected population". Managing and implementing such an efficient flow and cost-effectiveness of relief products necessitates the systematic coordination of specific operations and stakeholder collaboration to achieve humanitarian goals (Dubey et al., 2018; Li et al., 2019). The lack of coordination within the humanitarian supply chain may lead to inefficiencies that have a detrimental influence on the welfare of beneficiaries, i.e., an increase in the number of victims (Anjomshoae et al., 2022). Governments, humanitarian aid organizations, and other aid providers have become more aware of humanitarian logistics and the importance of coordination for successful and efficient relief item transport, procurement, and warehousing in recent years (Kovács & Spens, 2007).

The Internet of Things (IoT) based systems have recently been regarded as enablers of efficient coordinated environment in which humans, objects, machines, and software can efficiently interact with one another with limited human instructions (Alon et al., 2019; Zhong et al., 2015). The Internet of Things (IoT) systems are managed by sensors that are located remotely and can communicate over the internet (Ben-Daya et al., 2019; Devi & Kumari, 2013). Recently there has been considerable attention towards IoT-based supply chain systems to tackle the HSC coordination challenges. IoT-based HSC coordination system promotes the traceability of information and increased logistics and monitoring operations among humanitarian actors to maintain efficient and cost-effective planning, implementation, and control process (Aranda et al., 2019; Haavisto & Goentzel, 2015). Despite the growing relevance and importance of IoT systems in business and industrial systems, the humanitarian supply chain is still lacking in understanding the application and ramifications of IoT systems in managing relief chain coordination. To this end, understanding IoT enablers for creating a coordinated relief chain helps to achieve effective

coordination, accurate situational awareness, and comprehensive visibility of relief operational resources. This research thus aims to identify key IoT enablers that facilitate efficient humanitarian supply chain coordination.

BACKGROUND

Role of IoT in Supply Chain Coordination

IoT is defined by Botta et al. (2016) as a network with sense-based entities. Cloud computing, data management, and data networking are the three essential components of IoT technology (Chandrakanth et al., 2014). IoT enables physical objects to connect and share data in the real time to achieve coordination. Implementing associated technologies such as cloud computing, networking, data collection, IoT protocol, and other applicable technologies makes these entities smarter (Al-Fuqaha et al. 2015). The deployment of IoT technology may result in an efficient and resilient coordinating system through the transmission of data and resources in a transparent and observable manner between supply chain partners. In addition, IoT adoption provides precise and monitored dynamic data across the upstream and downstream flows of service-oriented businesses, which is necessary for HSC resilience (Wellington and Ramesh 2017). IoT adoption can be achieved in inventory management, improving different relief practices and integrating their strategies and improving operations performance by improving resilient capabilities in the event of an HSC disruption (Reaidy, Gunasekaran, and Spalanzani 2015).

METHODOLOGY

This research adopts the DEMATEL methodology to formulate the relationships among barriers. DEMATEL was first introduced by the Geneva Research Centre of the Battelle Memorial Institute in 1971. This technique visualizes complicated, structural, and causal relationships with matrices or digraphs. It formulates the relationship between criteria into a structural model (Guo et al., 2015; Mangla et al., 2020; Sahebi et al., 2022; Shahin et al., 2019). To collect data, a field survey was conducted in major Iranian humanitarian organizations such as the Iranian Red Crescent society. DEMATEL incorporates experts' opinions using interviews. Two experts from the IT industry, two from IoT solution companies, one from a non-governmental organization (NGO), two government experts from the Iranian Red Crescent Society, and one from academia participated in this research. All of the specialists have a minimum of ten years of expertise in their field. Experts were requested to rank the enablers. The enablers' judgment matrix is constructed based on the experts' ratings. Figure 1 depicts the research structure.

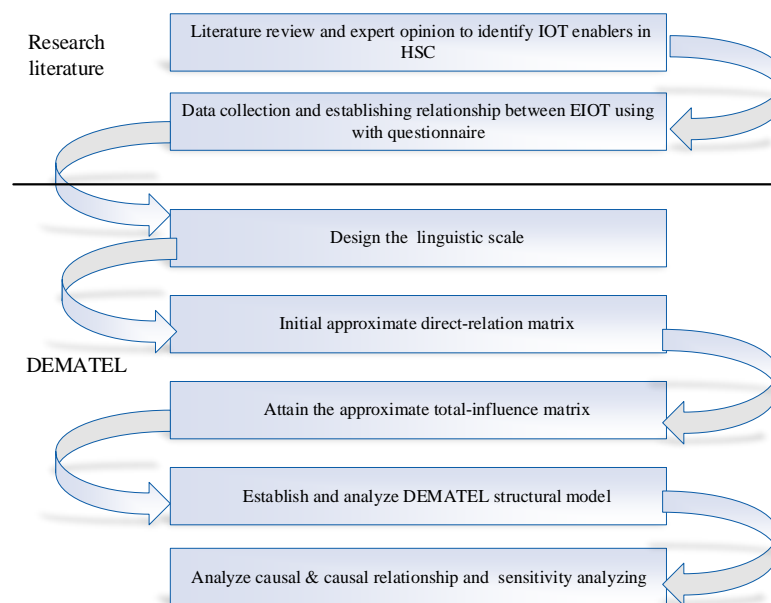


Figure 1: Research methodology framework

The structural diagram was created by measuring correlations among seven primary enablers using the DEMATEL approach. The DEMATEL technique consists of five phases to formulate causal relations between enablers. The DEMATEL calculation stages are given here, with just the enablers-level results being revealed. About identification, primary facilitators in HSC (Table 1), and questionnaire recovery:

Step 1: Using the survey average to calculate the first relationship matrix

Based on case managers and experts, an initial relationship matrix for criterion was created, as shown in Table 2.

Step 2: Calculation of normalized direct relationship matrix (See Table 3).

Step 3: Calculation of the total influence matrix (See Table 4).

Step 4: Calculation the sum of rows and columns

The sum of columns and rows from the entire influence matrix must be determined. The sum of columns and rows is represented by the vector's 'D' and 'R,' respectively. Table 5 displays the total number of columns and rows.

Step 5: Setting up the causal influence diagram

The last step in using the DEMATEL model is to create an influential graph, which aids decision-makers in identifying the most critical element.

The mean value of the total relation matrix is used to compute the threshold value, which is 0.11 at the criteria level. When the impacts of the criteria in the "total influence matrix" surpass a certain threshold, they should be represented in a causal diagram with arrows. "The influence network relation map" is another name for it. Similarly, if enablers' overall influence matrix impact is less than the threshold value, they have limited influence on other enablers.

RESULTS

Formulating IoT Enablers of Humanitarian Supply Chains Coordination

A literature survey was conducted using search keywords such as the IoT-based coordination system, HSCs, and IoT-based coordination in major scientific databases to formulate IoT enablers. Nineteen enablers have been identified as listed in Table 1. The enablers are then classified into seven dimensions after several interviews rounds with humanitarian practitioners.

Table 1: IoT enablers for HSC coordination

Classification	Enablers	References
Management Support (EIOT1)	Investment of time and money for resource development like IoT-based infrastructure and other training programs within the organization (EIOT ¹¹) Ready to adopt new technology, e.g., IoT, cloud computing, and big data computational, for improving the information sharing within the SC (EIOT ¹²) Employees' training and empowerment to enhance the skill and knowledge needed in IoT-based technical environment of work culture (EIOT ¹³) Focused on the communication system of the HSC during managing logistics, warehousing, and other service-providing activities (EIOT ¹⁴)	(Anjomshoae et al., 2017, Söderberg & Bengtsson, 2010; Sun et al., 2009)
Supply chain accountability (EIOT 2)	Quick organization's reactions to meet the continuing changing demand of the injured people for achieving resilience capabilities (EIOT ²¹) Fast exchange of real-time information in HSCM to provide flexibility/resilience and awareness among the actors in the SC (EIOT ²²) The resilience of HSC to adapt new technology during the relief of basic practices and the interpretation of data generated (EIOT ²³)	(Anjomshoae et al., 2021; Aranda et al., 2019; León-Bravo et al., 2019)
Supply chain integration (EIOT3)	Integration along with multiples SC with heterogeneous technologies for sharing the technical facilities across the inter and intra-organization boundaries (EIOT ³¹) Information integration among the members for monitoring or controlling the activities (EIOT ³²) Process integration means complete collaboration among the SC system members in strategically, tactically, and operational decision-making (EIOT ³³)	(Flynn et al., 2010)
Internet of things infrastructures (EIOT4)	A proper cloud computing system for better IoT network availability to access the services regarding information exchange (EIOT ⁴¹) A proper security support system to avoid unauthentic data sharing for misusing the information (EIOT ⁴²) Proper technical human resources for managing IoT-based disasters and actors' controlling mechanisms (EIOT ⁴³)	(Leong et al., 2011; Bo & Wang, 2011; Channe et al., 2015; Kaewkitipong et al., 2012)
Data subscription (EIOT5)	Use of IoT technology for subscription to the local and outer data of the organization by different members of the SC based on local Object Naming Service (ONS), global ONS, and Electronic Data Exchange (EDI) (EIOT ⁵¹) Knowledge subscription between the supply chain members with the help of research and development programs in the organizations (EIOT ⁵²) Tracking of logistics information by the managers during the transportation of products regarding the condition of the products and avoid the disorder (EIOT ⁵³)	(Tim et al., 2017; Marić et al., 2021; Zhang & Chen, 2013)
Trust development (EIOT 6)	Trust development in SC members so that all of the activities are executed to achieve a common goal without any conflicts of interest among the members (EIOT ⁶¹) Agreed vision and goals of members of the SC so that a shared effort of every actor leads to overall performance improvement for the organization. (EIOT ⁶²) Share standard protocols in IoT-based systems for efficiently interpreting the information generated from new technologies of IoT. (EIOT ⁶³)	(Bianchi & Saleh, 2010)
Third-party logistics service providers (EIOT7)	3PLs for IoT-based infrastructure support by providing different equipment and hardware. (EIOT ⁷¹) 3PLs for warehouse management for managing the tracking of shipment planning and distributing the required demands. (EIOT ⁷²)	(Aguezzoul, 2008; Göl & Çatay, 2007)

Modeling IoT Enablers for Humanitarian Supply Chains Coordination Using DEMATEL

According to $D + R$, important network relation maps are graphed in Figure 2, and $D - R$ values are provided in Table 5. We can now clearly see if an enabler is an effect or a cause and the amount it impacts or is influenced by others in the IRM.

Table 2: Initial relationship matrix at the enablers level

	<i>EIOT1</i>	<i>EIOT2</i>	<i>EIOT3</i>	<i>EIOT4</i>	<i>EIOT5</i>	<i>EIOT6</i>	<i>EIOT7</i>
<i>EIOT1</i>	0	3.5	2.5	3.5	3	3.25	3
<i>EIOT2</i>	1	0	2	2.75	3.25	3	0.5
<i>EIOT3</i>	1.75	1.75	0	2.5	3.25	3	2.25
<i>EIOT4</i>	1	3	3.25	0	2.75	2.75	3.5
<i>EIOT5</i>	1.75	2.25	3.25	2	0	2.75	2
<i>EIOT6</i>	0	2.5	3.5	2.25	1	0	1
<i>EIOT7</i>	1.5	3	2.75	3.25	1.5	1.75	0

Table 3: The normalized direct relationship matrix

	<i>EIOT1</i>	<i>EIOT2</i>	<i>EIOT3</i>	<i>EIOT4</i>	<i>EIOT5</i>	<i>EIOT6</i>	<i>EIOT7</i>
<i>EIOT1</i>	0	0.186	0.133	0.186	0.160	0.173	0.160
<i>EIOT2</i>	0.053	0	0.106	0.146	0.173	0.160	0.026
<i>EIOT3</i>	0.093	0.093	0	0.133	0.173	0.160	0.120
<i>EIOT4</i>	0.053	0.160	0.173	0	0.146	0.146	0.186
<i>EIOT5</i>	0.093	0.120	0.173	0.106	0	0.146	0.106
<i>EIOT6</i>	0	0.133	0.186	0.120	0.053	0	0.053
<i>EIOT7</i>	0.080	0.160	0.146	0.173	0.080	0.093	0

Table 4: Total influence matrix

	<i>EIOT1</i>	<i>EIOT2</i>	<i>EIOT3</i>	<i>EIOT4</i>	<i>EIOT5</i>	<i>EIOT6</i>	<i>EIOT7</i>
<i>EIOT1</i>	0.219	0.620	0.629	0.626	0.577	0.634	0.501
<i>EIOT2</i>	0.199	0.311	0.449	0.442	0.449	0.472	0.276
<i>EIOT3</i>	0.258	0.449	0.407	0.485	0.493	0.522	0.393
<i>EIOT4</i>	0.243	0.533	0.591	0.403	0.506	0.546	0.469
<i>EIOT5</i>	0.253	0.456	0.540	0.453	0.336	0.500	0.372
<i>EIOT6</i>	0.130	0.373	0.449	0.369	0.306	0.277	0.255
<i>EIOT7</i>	0.242	0.489	0.516	0.506	0.413	0.456	0.276

Table 5: Centrality degree and cause-effect influence relations among the enablers.

Criteria	D	R	D+R	D-R	Rank
<i>EIOT1</i>	1.546	3.807	5.354	-2.260	7
<i>EIOT2</i>	3.233	2.602	5.836	0.632	4
<i>EIOT3</i>	3.584	3.010	6.593	0.576	1
<i>EIOT4</i>	3.286	3.2933	6.579	-0.007	2
<i>EIOT5</i>	3.083	2.914	5.996	0.169	3
<i>EIOT6</i>	3.411	2.161	5.570	1.250	5
<i>EIOT7</i>	2.542	2.902	5.442	-0.359	6

Values (i.e., $D+R$) represent the overall influence of each critical enabler on the whole management system in terms of 'prominence'. The relative or preference importance order for these identified enablers is presented as non-adoption of the Basel ban amendment based on the ($D+R$) values: Supply chain integration (*EIOT3*), IoT infrastructures (*EIOT4*), data subscription (*EIOT5*), SC responsiveness (*EIOT2*), and trust development (*EIOT6*). Despite the importance of each enabler, Supply chain integration (*EIOT3*) and infrastructures in the IoT (*EIOT4*) are placed first and second, respectively, with the greatest ($D+R$) values. Similarly, the 'relation' values (i.e., $D-R$) are utilized to arrange enablers into cause-and-effect groups based on the negative (net receive) and positive (net cause) values in the total relationship matrix. Following that, we used the values of the entire relationship matrix to calculate the threshold value (0.42217) of the detected criterion (Table 4). HSC policymakers should promptly address the enablers under the cause group when determining the enablers under the effect group. Experts classify the above criteria based on the distinct facilitators, importance, and proportional weight in the whole connection matrix. These enablers impact the effective implementation of the IoT in Iran.

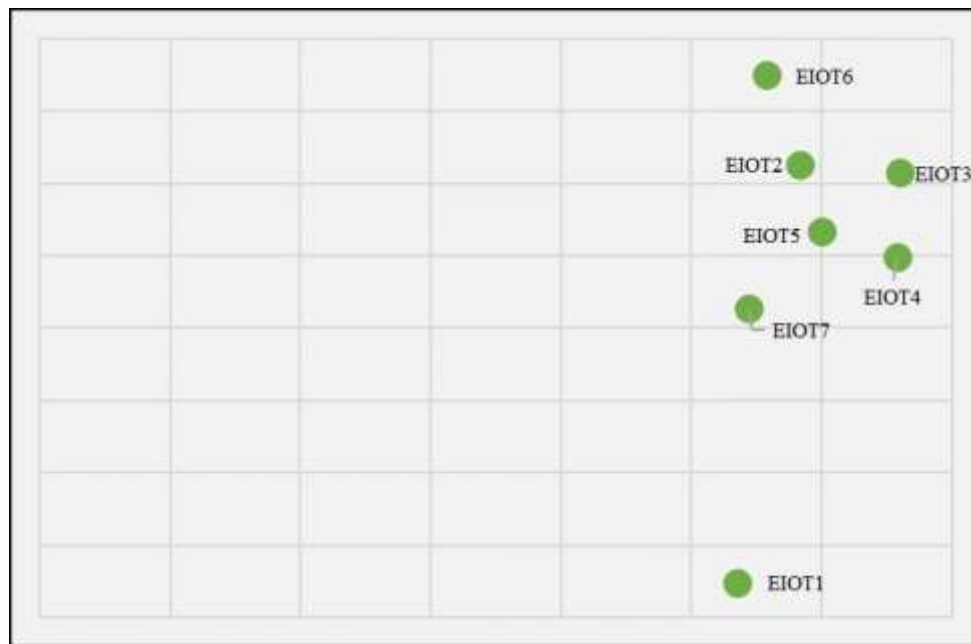


Figure 2: The overall degree of influence of IoT enablers in HSC

DISCUSSION

Management support (EIOT1) is the most significant cause enabler based on (D-R) value as an investment by Senior Managers in creating new technology such as IoT that is continually related to particular business practices. As a result, just a few IoT implications in HSC showed firms embracing new technologies and focusing on communication. This supports the findings of this study since top management support is the most critical enabler. The significant crucial aspects are senior managers' investment in relief programs, solving the issues of wounded individuals (hazard analysis and critical control point), and staff training in urgent situations.

Third-party logistics service providers (EIOT7) are the second most significant cause enabler in building IoT-based coordination for HSC. Third-party logistics providers are external service providers specializing in processing, logistics, and storage during the shutdown of logistics and other organizations' operations due to a natural HSC interruption. 3PLs are satisfying the time-sensitive needs of wounded individuals at a lower cost, delivering services to organizations (Domingues et al., 2015). SC's logistics operations were mostly outsourced to third-party logistics service providers, inventory management, human services, and IoT-based infrastructure.

IoT infrastructures (EIOT4) are the third impact enabled by other factors for constructing an efficient coordination system. A suitable security support system, followed by a qualified technical workforce for HSC activities such as safe storing of products and equipment, secure logistics activities using IoT-based traceability, network availability support with an appropriate cloud computing system, and a suitable automation system for traditional relief procedures, play a significant role in IoT based infrastructure systems. IoT-based SC operations, big data analytics, and other protocols inside HSC are examples of integrating IoT technologies or establishing IoT-based infrastructure (Aranda et al., 2019).

Data subscription (EIOT5) is the fourth effect enabled by other factors for constructing an efficient coordination system. IoT technology in information sharing is critical because it facilitates cooperation between HSC's upstream and downstream operators by providing a significant volume and delivery flexibility in response to demand changes (Deak et al., 2013).

Supply chain integration (EIOT3) is the fifth effect enabled by other factors for producing an efficient coordinating system. It primarily depends on integration and numerous SC with diverse technology to integrate supplier-related information and activities. Integrating relief efforts is not a one-way street; it entails understanding multiple strategic, operational, and tactical procedures at organizational levels, affecting most of the criteria (Vallet-Bellmunt & Rivera-Torres, 2013).

Supply chain accountability (EIOT2) is classified as a sixth key cause enabler that affects the whole coordinating system. It promotes resilience or flexibility, improving HSC adaptation to risk management during natural disasters (COVID-19). The responsiveness of SCs impacts obtaining dependability, agility, and speedy data transmission, among other things, which helps to improve various procedures (Cohen, 2020).

Supply chain integration (EIOT3) is the fifth effect enabled by other factors to produce an efficient coordinating system. Integrating relief efforts is not a one-way street; it entails understanding various strategic, operational, and tactical procedures at organizational levels, affecting most of the criteria (Vallet-Bellmunt & Rivera-Torres, 2013).

Supply chain accountability (EIOT2) is classified as a sixth key cause enabler that affects the whole coordinating system. The fast interchange of real-time information in the HSC is the most critical factor in SC responsiveness. It promotes flexibility or resilience, improving HSC adaptation to risk management during natural disasters (COVID-19). SC responsiveness impacts obtaining dependability, agility, and speedy data transmission, among other things, which helps to improve various procedures (Cohen, 2020).

Trust development (EIOT6) is the seventh key cause facilitator impacting other criteria. A slew of sub-enablers also accompanies it. Mutual understanding and trust aid in developing shared ideas and goals among HSC actors and wounded people and the sharing of standard protocols in an IoT-based system. As a result, trust development is required to effectively implement new technologies to establish a better HSC coordination system.

CONCLUSION

In humanitarian supply chains sharing accurate information in real-time during disasters is crucial for coordinating limited resources and preventing further loss of life. Recently, the Internet of Things (IoT) has gained recognition as a pivotal tool for improving communication during emergencies, allowing for better coordination, better situational awareness, and greater visibility into available resources. Despite its relevance, the process of adapting it and putting it into practice has been difficult. The purpose of this study is to gain an understanding of the Internet of Things enablers that are necessary for the coordination of humanitarian supply chains. Seven dimensional enablers have been formulated by reviewing the literature and validating with practitioners' opinions. A structural model is then developed using the Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique that addresses the interdependencies of IoT enablers in humanitarian supply chain coordination. These enablers help HSC integrate IoT more effectively. Management support (EIOT1) is a critical influencing facilitator; this indicates that management must take a proactive and policy-driven approach. This research contributes to practice by increasing the awareness of relief procedures and incorporating IoT into the relief coordination system. It will also increase awareness of the technological relief difficulties that IoT adoption will almost certainly encounter. The study was based on a small number of experts and respondents. The DEMATEL approach is highly dependent on the expert panels decision. Using statistical techniques such as structural equation modeling may provide additional insights.

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Performance evaluation on the implementation of Pre-established Medical Processes for nurse practitioners in the hospitals

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ABSTRACT

In 2015, Taiwan announced the establishment of “Pre-established Medical Processes” and related regulations to assist nurse practitioners in the clinical tasks, maintain medical quality and patient safety, and provide protection in clinical practice. However, the effectiveness of implementation still needs to be improved and strengthened. This study adopts the TAM and the TTF as the research framework, and a cross-sectional design. The questionnaires are administered to the professional nurse practitioners in the hospitals of central Taiwan. A total of 300 questionnaires were distributed, and Smart PLS 3.0 and SPSS 24.0 were both applied to verify interpretability. The questionnaire recovery rate was 88.3%, and the overall predictive power was 65.2%. Technological characteristics and TTF had a significant impact on perceived usefulness.

Keywords: Nurse Practitioners, Pre-established Medical Processes, Computerized Provider Order Entry, Technology Acceptance Model, Task-Technology Fit.

INTRODUCTION

With the rapid development of information, the continuous advancement of various information technologies, the continuous adjustment of the national health insurance and the increasing competition in the overall medical environment, hospitals have begun to develop into smart hospitals, and have successively built Healthcare Information Systems. To assist clinical medical and administrative operations to reduce the risk of treatment errors, prevent the occurrence of medical errors, save medical costs, improve the quality of medical services and patient safety, and allow patients to receive appropriate treatment and preventive health services (Dana *et al.*, 2021). In 2000, Taiwan incorporated nurse practitioners into the Nursing Personnel Act, giving them a legal basis for their practice. However, the incomplete legal norms and connection systems affected the role function orientation and work content consensus and even led nurse practitioners to face challenges. With the doctors and nurses' joint efforts and the Ministry of Health and Welfare's successive amendments to regulations, the “Regulations Governing Nurse Practitioners Carrying out Medical Activities under the Supervision of a Physician” were announced in October 2015 to standardize the content of medical services that nurse practitioners can perform under the supervision of doctors. Concomitantly, it was clearly stipulated that the medical procedures and related regulations must be pre-established by physicians (Law & Regulations Database of The Republic of China [Taiwan], 2017). In the current medical environment, nurse practitioners play an important role between medical treatment and nursing. The work content is complex and professional. The establishment of "Pre-established Medical Processes" can help nurse practitioners achieve practical work, thereby reducing clinical work pressure. A good information system must have a user-friendly interface to enable smooth operation (Huang *et al.*, 2021). If the design is poor, the system interface lacks fluency, or the connection with the surrounding information system is missing, it will not be able to play its effectiveness, and may also lead to medical negligence. Therefore, the system should have corrected clinical guidelines, conform to clinical usage habits, and interface design for ease of use, in order to effectively use the "Pre-established Medical Processes" to improve system satisfaction and work efficiency.

LITERATURE REVIEW

Development and practice status of nurse practitioners

The origin of Taiwan's nurse practitioner's system lies in the shortage of doctor manpower supply, changes in the medical payment system and the continuous increase in demand for nursing care, so senior nurses who are familiar with medical procedures are used to perform part of the medical work to maintain the balance of medical supply and demand and the health of the people. care needs, and cooperate with physicians to provide continuous and integrated medical and nursing care (Qiu, 2016). According to the Department of Healthcare of the Ministry of Health and Welfare, as of 2021, 13,341 have passed the screening and obtained the certificate of specialist nurse practitioner. Currently, 98% of them provide medical and nursing professional services in relevant medical places (Department of Nursing and Health Care, Ministry of Health and Welfare, 2022; Lin et al., 2021). On October 24, 2000, the Legislative Yuan passed the third amendment to Article 7-1 of the "Nursing Personnel Act", listing "nurse practitioners" as one of the legal names. In 2006, he started to hold the examination of nurse practitioners and became an advanced nurse with a national certificate in Taiwan (Law & Regulations Database of The Republic of China [Taiwan], 2020). Nurse practitioners perform related medical services in accordance with Articles 7 and 24 of the Nursing Personnel Act to ensure the quality of practice and patient safety.

Pre-established Medical Processes

Medical quality and patient safety are the tenets of "Pre-established Medical Processes". According to Article 5 of "Regulations Governing Nurse Practitioners Carrying out Medical Activities under the Supervision of a Physician", contains the following: "(1) Conditions or diagnoses such as symptoms, medical history, physical assessments; (2) Implementation items; (3) Relevant treatments and measures; (4) Written records; (5) The supervising physician and supervision method; (6) Specific training standards or requirements that nurse practitioners and nurse practitioners in training shall meet" (Law & Regulations Database of The Republic of China [Taiwan], 2017). Through "Pre-established Medical Processes", various disease symptoms are integrated into standard specifications according to medical measures and steps, which can help reduce medical negligence due to human errors, maintain medical quality, and ensure patient safety, and can also be guaranteed in clinical practice.

Technology Acceptance Model

Davis developed the Technology Acceptance Model in 1989 based on rational behavior theory, which is used to explain and predict users' acceptance of new information technology and to analyze various factors affecting users' internal beliefs, attitudes, and willingness. In the dimension of TAM, Davis believes that "perceived usefulness" and "perceived ease of use" are the two most important variables affecting users' attitudes towards accepting information technology, which impacts users' behavioral intentions and actual use behavior.

Task-Technology Fit Model

The task-technology fit model was proposed by Goodhue and Thompson (1995) to explore the theory of the relationship among the three dimensions, task characteristics, technological characteristics, and individual characteristics. This theory holds that users must accept and be willing to use information technology. In addition, a good cooperation is needed between information technology and tasks so that the tasks can be performed smoothly and the performance can be improved (Goodhue and Thompson, 1995).

Integration of Technology Acceptance Model and Task-Technology Fit Model

In 1999, Dishaw and Strong found that the TAM is similar to the task-technology adaptation model. They believed that the latter would affect cognitive usefulness and cognitive ease of use and eventually the actual use. The technology acceptance model and task-technology fit model strengthen the model's acceptance and explanation degree for technology, and the integrated explanatory power becomes higher than that of the single model.

Computer Self-Efficacy

According to the perspective of social cognitive theory, self-efficacy refers to an individual's judgment of the ability to complete a task or achieve a goal (Bandura, 1986). Compeau and Higgins (1995) extended self-efficacy to computer self-efficacy. For a specific job or task, whether an individual has the ability to use the information system to complete the task's self-evaluation and cognition, and confirmed that the better the user's computer self-efficacy performance, the better the computer self-efficacy.

Subjective Norm

Subjective norm refers to the behavioral attitude of an individual that is influenced by the external environment or pressure to demonstrate a specific behavior or use (Ajzen & Fishbein, 1980). The research results of Venkatesh and Davis (2000) show that subjective norms can directly or indirectly affect the willingness to use information technology through perceived ease of use. Ursavaş et al. (2019) pointed out that subjective norm is an important variable of medical personnel's adoption of technology, which directly affects actual use, and will be pressured by social opinions or regulations to influence people's behaviors to comply with opinions or regulations.

Performance Measurement of Medical Institutions

The Balanced Scorecard is a multidimensional performance management tool proposed by Kaplan and Norton (1992). It combines financial and nonfinancial indicators to develop a scorecard model, which expands the performance measurement to four dimensions: customer, internal process, learning, and growth. In addition to general enterprises, it also includes the field of health care, and the Balanced Scorecard was considered as an important strategic management tool for the health care industry as early as 1994 (Trotta et al., 2013).

HYPOTHESIS DEVELOPMENT AND FRAMEWORK

Research framework

This study used the “technology acceptance model” and “task-technology fit model” proposed by Dishaw and Strong (1999) as the theoretical bases of the research framework to investigate the use of “pre-established medical processes” by nurse practitioners and whether their fit affects the actual use and the job performance. According to the literature review, computer self-efficacy affects the use of new information systems to complete related tasks; thus, it is included in the research framework. Furthermore, the subjects included in this study were nurse practitioners who were required to use the “pre-established medical processes” in assisting in the issuance of medical orders in accordance with the regulations. Thus, the task characteristics in the task-technology fit will not affect other variables. However, the adoption of the system will be affected by subjective norms within the organization and will have different effects according to the characteristics of the users. Therefore, these two variables are regarded as moderating variables.

Research Hypothesis

Goodhue and Thompson (1995) pointed out that if the information technology can meet and support the needs of work tasks, it will improve users’ willingness to use such a technology. Dishaw and Strong (1999) research shows that task-technology fit affects perceived usefulness and perceived ease of use, which in turn affects usage. Therefore, this study proposes the following hypotheses: H1: The technology features positively affect the perceived usefulness of the “pre-established medical processes” among nurse practitioners "; H2: The technology characteristics positively affect the perceived ease of use of the “pre-established medical processes” among nurse practitioners.

In information management research, computer self-efficacy is mainly used as an external variable of system users' behaviors toward the use of information systems (Compeau & Higgins, 1995). According to Abdulrab (2020), computer self-efficacy is related to an individual's ability, understanding, and belief in performing the tasks. Therefore, this study proposed the following hypotheses: H3: Computer self-efficacy positively affects the perceived usefulness of the "pre-established medical processes" among nurse practitioners; H4: Computer self-efficacy positively affects the perceived ease of use of the "Pre-established Medical Processes" among nurse practitioners.

Dishaw and Strong (1999) believed that task-technological fit model would affect the nurse practitioners’ perceived usefulness, perceived ease of use, and willingness to use. Debajyoti and Syamal (2020) research shows that college students suffer from COVID-19 -The task of using online learning in the 19th period-Technology adaptation has a significant positive correlation with perceived usefulness and perceived ease of use. Therefore, this study proposed the following hypotheses: H5: The task-technology fit positively affects the perceived usefulness of the "pre-established medical processes" among nurse practitioners; H6: The task-technology fit positively affects the Perceived ease of use of the "pre-established medical processes" among nurse practitioners; H7: Perceived ease of use positively affects the perceived usefulness of the "pre-established medical processes" among nurse practitioners.

Davis (1989) demonstrated that the two most important beliefs positively affecting users’ attitudes toward the use of information technology were "perceived usefulness" and "perceived ease of use". Dishaw and Strong (1999) verifies that the adaptation of tasks and technology affects perceived ease of use and perceived usefulness, which in turn affects the actual use. Therefore, this study proposed the following hypotheses: H8: Perceived usefulness positively affects the actual use of "pre-established medical processes" by nurse practitioners; H9: Perceived ease of use positively affects the actual use of "Pre-established Medical Processes" by nurse practitioners.

Goodhue and Thompson (1995) proposed that when the user has the task characteristics endowed by a clear cognitive self, there will be a positive perception and evaluation of the task-technology fit. Dishaw & Strong (1999) believed that the task-technological fit affects perceived ease of use, perceived usefulness, and willingness to use. Karimi et al. (2004) employed the organizational theory to study users’ satisfaction with the use of information systems under environmental uncertainty and task characteristics. The results indicated that the task characteristics had direct and mediating effects on user satisfaction. Therefore, this study proposed the following hypotheses: H10a: Task characteristics have a moderating effect on the relationship between the task-technological fit and perceived usefulness; H10b: The task characteristics have a positive effect on the relationship between the task-technology fit and perceived ease of use adjust the effect.

Venkatesh and Davis (2000) proposed that subjective norms indirectly affect technology adoption through perceived usefulness and perceived ease of use. If majority of the significant people in the group use the system, perceived usefulness will be positively affected, whereas perceived ease of use will be positively affected if used by an increasing number of people in a group (Venkatesh & Davis, 2000; Venkatesh & Bala, 2008). Therefore, this study proposes the following hypotheses:

H11a: Subjective norm has a moderating effect on the relationship between perceived usefulness and actual use; H11b: Subjective norm has a moderating effect on the relationship between perceived ease of use and actual use.

Design

The questionnaire followed a structured design. The difference in the degree was expressed as an interval scale, and a five-point Likert scale was used to differentiate its degree as follows: “strongly disagree (1) to strongly agree (5).” To make the content of the questionnaire reliable and valid, after completing the questionnaire design, the academic and medical circles were invited to discuss and revise the content of the questionnaire and the meaning of the questions.

Participants

The recipients are the practicing nurse practitioners in the hospitals in central Taiwan.

Data Collection

Data was collected in April 2022. A total of 300 questionnaires were distributed, and 240 individuals responded. After collecting the questionnaires, they were screened, and invalidated questionnaires were excluded. If the contents of the questionnaires were omitted and the medical information system did not establish a “pre-specified medical procedure,” this study would be considered invalid. After the screening, 212 valid questionnaires were identified, indicating an overall effective questionnaire recovery rate of 88.3%. SPSS 24.0 was used to conduct descriptive statistical analysis on valid samples, and Smart PLS 3.0 was used to verify the research model of the structural equation modeling.

FINDINGS

Basic Information of Nurse Practitioners

In this study, SPSS 24.0 was used to conduct descriptive statistical analysis on the basic data obtained from the 212 valid questionnaires. The analysis results are presented in Table 1.

Table 1: Basic data descriptive statistical analysis

Statistical item	n	%	
Gender	Male	7	3.3
	Female	205	96.7
Education level	Associate degree	3	1.4
	Bachelor's degree	182	85.8
	Master's degree	25	11.8
	Doctorate degree	2	0.9
Certificate Section	Internal Medicine	74	34.9
	Surgical	97	45.8
	Psychiatric	7	3.3
	Pediatrics	20	9.4
	Obstetrics and Gynecology	14	6.6
Clinical experience	Below 5 years	36	17.0
	6~10 years	59	27.8
	11~15 years	54	25.5
	16~20 years	46	21.7
	More than 21 years	17	8.0
Age	Below the age of 29	6	2.8
	30~39 years old	49	23.1
	40~49 years old	140	66.0
	Over 50 years old	17	8.0
Seniority of Individuals Using Medical Information System	Below 5 years	17	8.0
	6~10 years	47	22.2
	11~15 years	65	30.7
	16~20 years	57	26.9
	More than 21 years	26	12.3

Source: This study.

Descriptive Statistical Analysis of Research Items

SPSS 24.0 was used for the descriptive statistical analysis based on 212 valid samples. The analysis results are presented in Table 2.

Reliability and Validity Analysis

Reliability Analysis

SPSS 24.0 was used to analyze the reliability of 212 valid questionnaires. The overall Cronbach's alpha value of the analysis results was 0.952, which is within the acceptable range. In this study, the Cronbach's alpha values ranged from 0.753 to 0.945. Values greater than 0.7 indicate that the research is internally consistent and has a certain degree of reliability.

Validity Analysis

SPSS 24.0 was also used to conduct KMO and Bartlett's spherical test on 212 valid questionnaires. The KMO values in this study ranged from 0.672 to 0.864 and were all greater than 0.6, indicating that there were common factors among the variables of this scale, and the p-values of the spherical test statistics were all a significant level of $0.000 < \alpha = 0.01$ indicates that it is suitable for factor analysis. In this study, the average extracted variance was greater than 0.5, the combined reliability was greater than 0.7, and the factor loading was greater than 0.5 (Hair et al., 2010), indicating that all aspects of this study have good convergent validity, as presented in Table 2. The minimum value of the average variation extraction of the facets in this study was greater than the square of the maximum value of the correlation coefficient between facets, indicating that each facet has good discriminant validity. The results are presented in Table 3.

Table 2: Mean, SD, AVE, CR and factor loadings

Dimension	Question code	Mean	Standard deviation	Average variance extracted	Composite reliability	Factor loadings
Technology Characteristics	EC1	3.15	0.861	0.809	0.944	0.895
	EC2	3.09	0.816			0.859
	EC3	3.29	0.829			0.941
	EC4	3.41	0.850			0.901
Computer self-efficacy	CSE1	3.34	0.888	0.669	0.858	0.758
	CSE2	3.69	0.828			0.858
	CSE3	3.89	0.744			0.833
Task-Technology Fit	TTF1	3.42	0.800	0.741	0.934	0.759
	TTF2	3.11	0.909			0.814
	TTF3	3.28	0.888			0.857
	TTF4	3.28	0.865			0.934
	TTF5	3.32	0.835			0.927
Task Characteristic	TC1	3.20	0.891	0.777	0.932	0.869
	TC2	3.34	0.805			0.956
	TC3	3.33	0.797			0.944
	TC4	3.76	0.832			0.740
Perceived Usefulness	PU1	3.46	0.854	0.859	0.961	0.903
	PU2	3.35	0.932			0.943
	PU3	3.36	0.944			0.935
	PU4	3.33	0.923			0.926
Perceived Ease of Use	PE1	3.77	0.732	0.641	0.877	0.807
	PE2	4.02	0.697			0.848
	PE3	4.10	0.755			0.793
	PE4	4.10	0.723			0.752
Subjective Norm	SN1	3.81	0.766	0.742	0.896	0.793
	SN2	3.50	0.844			0.885
	SN3	3.52	0.866			0.901
Actual Use	AU1	3.68	0.852	0.626	0.921	0.732
	AU2	3.61	0.843			0.756
	AU3	3.54	0.791			0.780

Source: This study.

Table 3: AVE square root correlation matrix

	CSE	PU	PE	EC	AU	TTF	TC	SN
CSE	0.818							
PU	0.259	0.927						
PE	0.444	0.189	0.801					
EC	0.245	0.648	0.151	0.899				
AU	0.367	0.573	0.348	0.531	0.791			
TTF	0.312	0.802	0.244	0.699	0.605	0.861		
TC	0.268	0.770	0.278	0.600	0.594	0.761	0.881	
SN	0.399	0.258	0.358	0.296	0.692	0.288	0.272	0.861

Source: This study.

Structural Model Analysis

In this study, the BootStrap test method was employed to test the path coefficient of 212 valid questionnaires using SmartPLS 3.0, and the path coefficient (β) and t-value were calculated. The test results are presented in Table 5. The least squares method

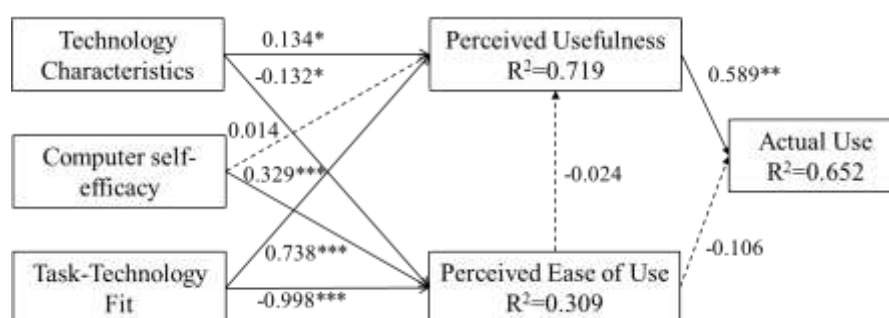
PLS used the coefficient of determination R^2 to detect the prediction degree of the entire model, which refers to the percentage of variation that can be explained by the exogenous to the endogenous aspects. The R^2 value of "Perceived Ease of Use" is 0.309; "Perceived Usefulness," 0.719; and "Actual Use," 0.652, all of which have good explanatory power. The path analysis of the overall research structure is presented in Figure 1.

Table 4: Direct path coefficient and hypothesis

Hypothesis	Paths	Beta	t-value	p-value	Decision
H1	Technology Characteristics → Perceived Usefulness	0.134	1.839	0.066*	Accepted
H2	Technology Characteristics → Perceived Ease of Use	-0.132	1.658	0.097*	Accepted
H3	Computer self-efficacy → Perceived Usefulness	0.014	0.290	0.772	Rejected
H4	Computer self-efficacy → Perceived Ease of Use	0.329	4.043	0.000**	Accepted
H5	Task-Technology Fit → Perceived Usefulness	0.738	5.780	0.000**	Accepted
H6	Task-Technology Fit → Perceived Ease of Use	-0.998	3.997	0.000**	Accepted
H7	Perceived Ease of Use → Perceived Usefulness	-0.024	0.598	0.550	Rejected
H8	Perceived Usefulness → Actual Use	0.589	2.036	0.042**	Accepted
H9	Perceived Ease of Use → Actual Use	-0.106	0.444	0.657	Rejected

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Source: This study.



Source: This study.

Figure 1: Path analysis of the overall research structure (* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$)

Adjustment Effect Check

In this study, task characteristics and subjective norm variables were added to the research framework to adjust the effect, and the standardization method was adopted to overcome the multicollinearity problem caused by the calculating interaction variables. The statistical results are presented in Table 5. At present, the "pre-established medical processes" in each medical institution are set up for common diseases, but the clinical diseases are diverse; thus, it is difficult for nurse practitioners to obtain the correct information when using the "pre-established medical processes" in assisting in the issuing of medical orders. Information is required, and it is difficult to effectively use information and achieve task and technology adaptation. However, if a nurse practitioner feels that a colleague or supervisor thinks that the "pre-established medical processes" is easy to operate, and has a strong belief in compliance with the regulations and policies of the Ministry of Health and Welfare, they will perceive that the "pre-established medical processes" is easy to use. It is stipulated in the regulations that "pre-established medical processes" can only be opened after specific training standards or requirements. Therefore, after the nurse practitioners have been educated and trained to open the medical information system, it will be easy to operate in terms of ease of use.

Table 5: Adjustment effect path coefficient test

Hypothesis	Task	Characteristic	Subjective	Norm	Paths	Beta	t-value	p-value
H10a					Task-Technology Fit → Perceived Usefulness	-0.073	2.148	0.032**
H10b					Task-Technology Fit → Perceived Ease of Use	0.192	4.072	0.000***
H11a					Perceived Usefulness → Actual Use	-0.020	0.305	0.760
H11b					Perceived Ease of Use → Actual Use	0.093	1.889	0.059*

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Source: This study.

CONCLUSIONS AND RECOMMENDATIONS

Research Conclusion and Discussion

Based on the "Technology Acceptance Model" and "Task-Technology Fit" integrated model proposed by Dishaw and Strong (1999), this study investigated the behavioral research on the use of "pre-established medical processes" by practicing nurse practitioners. Whether the allocation affects the actual use intention, and thus affects the job performance. Behavior. The results indicated that the technological characteristics and task technological adaptation had a negative impact on cognitive ease of use. More than 50% of the nurse practitioners in this study were aged above 40 years and had at least 11 years of clinical experience and experience in using medical information systems. Their personal work habits have been developed for

a long time and were mainly based on their own working methods. Therefore, despite the "pre-established medical processes" with more detailed data and stronger functions, it will not affect the perceived ease of use. Furthermore, the nurse practitioners were all from the Department of Nursing and mainly focus on learning basic medical scientific knowledge and nursing skills. With the continuous growth of the Internet, learning, and use computer skills may be a little more frustrating in older than in young people. Hackbarth et al. (2003) demonstrated that lack of experience may cause anxiety toward the use of computers, which in turn inhibits users' perceived ease of use. Therefore, the functions provided by the system do not match, are difficult to learn, and lack flexibility, which may negatively affect perceived ease of use. In addition, nurse practitioners may think that the practicality and usefulness of the "pre-established medical processes" in clinical work are not very helpful, so the personal computer self-efficacy is high or low, which cannot affect the relationship between its perceived usefulness. Hu et al., (1999) showed that the applicability of physicians' use of telemedicine in healthcare was explained by the TAM. The result was that perceived ease of use has no positive effect on attitudes, indicating that users have the perceived ease of use of technology varies in importance. This study demonstrated that nurse practitioners place less importance on the perceived ease of use of "pre-established medical processes". Therefore, it is necessary to understand the clinical work characteristics and work content of nurse practitioners to plan for the "pre-established medical processes" and to analyze and evaluate the usefulness and ease of use of the system. As long as the system is easy to use and meets the needs of information, users' willingness to use will increase.

The overall research results indicated that the two dimensions of "technology characteristics" and "task-technology fit" have a significant impact on "perceived usefulness", and the path coefficient of the actual use that affects the "pre-established medical processes" The maximum value is "task-technology fit". From this, it can be seen that the main reason that affects the use of "pre-established medical processes" by nurse practitioners is whether the operation method is consistent with the original work flow, the content of the process needs to be in line with the changes in clinical conditions, and can effectively achieve the inspection-related items required by the patient. Only when the overall system design is easy to use can it help improve the quality of clinical work. If the acceptance of the "pre-established medical processes" can be improved and resistance to it be reduced, the success rate and satisfaction of the process introduction can be increased. This study verifies the task proposed by Goodhue & Thompson (1995). In the technology adaptation model, the user's performance of information technology comes from the task technology adaptation results, the information technology's cognition and experience, and the degree to which the user's needs meet the needs of the users. Therefore, the use of "pre-established medical processes" by nurse practitioners to assist in issuing medical orders can improve the quality of patient safety medical care, improve work efficiency and effectiveness, and thus improve work performance.

Recommendations for Management Practice

The purpose of adopting the "pre-established medical processes" is to make the practice of nurse practitioners more secure and to comply with the policies of the Ministry of Health and Welfare as well as the requirements of the hospital visit assessment project for nurse practitioner training. The management unit of the nurse practitioners When developing related processes or systems, it is necessary to first understand the needs of the users and work processes and to make plans with a focus on the user to enable a smooth implementation of the information system. In the early stage of the process introduction, seeded personnel can be arranged to provide immediate support in solving problems regarding the use. In addition, supervisors can provide care and encouragement to the users so as to reduce the feeling of rejection of the system by nurse practitioners and receive nurse practitioners' feedback on the system at any time. Feedback and assist with processing. The information department stabilizes the information quality during the system design, continuously monitors the system performance and evaluation results, and makes corrections and optimizations at any time according to clinical needs to achieve the maximum benefit of the system introduction. In Taiwan, the overall nurse practitioner's system has been gradually completed. The law clearly defines the scope and content of the practice and regulates the "pre-established medical processes," which enhances the independence of nurse practitioners in medical care. Therefore, in assisting in the issuance of medical orders, relevant laws and regulations should be followed to improve the safety of professional nurse practitioners and the quality of their tasks. It is expected that in the early stage of the system introduction, most people will have inertia, resist changes, or worry that their workload will increase and cause anxiety. These situations can be changed by improving computer-related knowledge, learning computer-related skills, and increasing self-confidence. The usability and usefulness of the system will enable the user to become confident during the transformation of the information system in the future, thereby improving the acceptance and work efficiency of the system.

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Research hotspots and trends of fresh e-commerce in China: A knowledge mapping analysis based on bibliometrics

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ABSTRACT

The fresh e-commerce industry has seen a sudden and substantial rise since the outbreak of COVID-19. The rapid development of this industry calls for a comprehensive and systematic review of its research status, hotspots and future trends, which will have significant implications for researchers in related fields. This paper first conducts a current situation analysis of the core literature on fresh e-commerce retrieved from four databases – CNKI, CSSCI, Wanfang and VIP – to categorize the research status of fresh e-commerce in three dimensions: the year of publication, article sources, and distribution of subjects. CiteSpace is then used to perform a bibliometric analysis of the data and to create visualized knowledge maps. The results show that the research on fresh e-commerce can be divided into three stages: rapid development (2012-2015), exploration and transformation (2016-2019), maturity and upgrade (2020-present). At each stage, the research evolves toward diversity and maturity with policy developments and changes in the external environment. Cold chain logistics, business models, freshness-keeping of products and e-commerce are ongoing research hotspots in fresh produce e-commerce, while later studies focus more on the transformation and upgrade of products, logistics, distribution and platforms to better serve consumers' consumption habits and environmental requirements. This study provides valuable insights for researchers and enterprises who are engaged in the industry and for those who are interested in the development of fresh e-commerce in China.

Keywords: fresh e-commerce; bibliometrics; hotspots and trends; COVID-19; Citespace.

INTRODUCTION

Since the COVID-19 pandemic swept the world in 2020, China has adopted strict control and prevention measures, during which process fresh e-commerce has played an important role in safeguarding people's livelihood and securing their daily necessities. The fresh e-commerce industry has witnessed a tremendous growth against this backdrop. According to the 2022 Insights Report on Fresh E-Commerce Industry in China released by MobTech, the gross merchandise value (GMV) of the fresh e-commerce industry has exceeded 400 billion yuan, with around 100 million monthly active users and a huge number of consumers that consume trillions of tons of fresh food products annually. What with the enormous consumption volume and the market potential, fresh e-commerce has been hailed as the "last blue ocean" of e-commerce. Under the "dynamic zero-case" policy and the strict control and prevention measures, the penetration rate of fresh e-commerce platforms to the traditional food market has increased from 2% in 2016 to about 10% in 2022 (Meng *et al.*, 2019). On April 7, 2022, the State Council issued the Implementation Opinions on Accelerating the High-Quality Development of Cold Chain Logistics and Transportation, encouraging the fresh e-commerce sector to further their efforts in building "last mile" facilities. Hence, two years into the pandemic, how to solve the problems in the development of fresh e-commerce has become a research hotspot for both enterprises and academia.

The current research on fresh e-commerce has focused on cold chain logistics (Tang, 2014), pricing (Song & He, 2019; Zheng *et al.*, 2019), distribution (Ge *et al.*, 2018; Yu & Xiao, 2021), and decision-making of freshness-keeping efforts. As early as 2013, Shen analyzed the strategies for developing fresh product e-commerce from the three aspects of product, logistics, and government, suggesting that the government should gradually improve relevant laws and regulations to support the upgrade of agricultural products and cold chain logistics (Shen, 2013). Zhang (2014) analyzed the concept, origin, development history, status and dilemma of the e-commerce of agricultural products and proposed recommendations correspondingly. Canavari *et al.* (2010) analyzed the differences between fresh e-commerce and traditional retail of fresh produce so as to establish a credibility system and improve its reliability value with regards to business models and operation strategies. As an emerging industry that only makes its appearance in recent years, fresh e-commerce has yet to reach its maturity and faces many problems that need to

be solved. It is important to conduct a timely, systematic and comprehensive review of the status, hotspots and trends of fresh e-commerce for future research. However, such literature review is currently scarce, if not absent. To provide a comprehensive understanding of the current status and latest trends of research in fresh e-commerce in China, this paper analyzes relevant research on fresh e-commerce from four mainstream databases in China, with the aim to provide valuable insights for researchers and enterprises who are engaged in the industry and for those who are interested in fresh e-commerce in China. This paper will contribute to the future research of fresh e-commerce, and its results will provide a reference for new development opportunities of the industry in the context of “new retail”.

This paper first retrieves literature data on fresh e-commerce research from CNKI, CSSCI, Wanfang and VIP. Meta-analysis and bibliometric analysis are then employed to sort out the status and conduct knowledge mapping of the 602 papers selected, which contributes to the better understanding of the development patterns and overall trends of fresh e-commerce research, advances future studies, and provides theoretical references for relevant research.

DATA SOURCES AND METHODOLOGY

Data Sources

This paper selects journal articles on fresh e-commerce published from January 2012 to June 2022 from CNKI, CSSCI, Wanfang and VIP databases as the research object. To ensure the authority, validity and extensiveness of the samples, we then pick the articles published in core journals as the data, which are more representative of the research hotspots and trends in this field. The fresh products in this paper include but are not limited to fruits, vegetables, meat, eggs, dairy products and aquatic products. Internationally, different terms with certain nuances of meaning have been used to describe fresh e-commerce, including: (a) fresh e-commerce; (b) fresh food e-commerce; (c) fresh produce e-commerce; and (d) fresh agricultural products e-commerce. In China, the same terms have been used consistently. In this paper, “fresh e-commerce” is used for retrieving information from the databases. Of all the articles published in core journals that are indexed in the four databases, 227 are retrieved from CNKI, 21 are from CSSCI, 572 are from Wanfang, and 174 from VIP. After importing articles and removing the duplicate ones using NoteExpress, 602 are left as the literature datasets of fresh e-commerce research for this paper.

Methodology

In this paper, we first perform a current situation analysis to count, classify and compare the 602 articles on fresh e-commerce from three dimensions – the year of publication, article sources, and distribution of subjects – to sort out the research status of the literature on fresh e-commerce. CiteSpace is then used to conduct a bibliometric analysis of the collected literature data and create visualized knowledge maps. Bibliometric analysis is a kind of quantitative analysis that uses statistical methods to describe, explain, evaluate, and predict the current status and emerging trends of relevant research by exploring the various characteristics of the literature (Baminiwatta and Solangaarachchi, 2021). CiteSpace is an open-source Java application developed by Prof. Chaomei Chen at the College of Computing and Informatics of Drexel University, USA. It is a visualization tool for analyzing scientific literature and is commonly used in bibliometric analysis. Knowledge mapping with CiteSpace takes “knowledge domain” as the subject of analysis, which can visualize the evolutionary process and structural relationship of scientific research on fresh e-commerce, and reveal the numerous, complex connections between knowledge domains in terms of structure and development (Chen, 2006). Keyword clustering, timezone, timeline, burst terms and other functions can visualize the research hotspots and trends of a specialty in a certain period of time.

DESCRIPTIVE ANALYSIS OF FRESH E-COMMERCE

Distribution of Literature

The distribution of literature can be categorized into the quantitative temporal distribution and the distribution of journals. The statistical analysis of the number of articles published annually can reveal the current status and development trends of fresh e-commerce research. Figure 1 shows the results of analysis of 602 articles. The top 3 years with the most publications are 2018, 2020 and 2021, with 92, 95, 80 published articles respectively. 2012 marked the “first year of fresh e-commerce”. In that year, two classic marketing cases – “Chu Orange entering the Beijing Market” and “the Battle over Litchi in Beijing” – quickly attracted the attention of social capital and set off an investment boom. Henceforth, the research related to fresh e-commerce has been on the rise year by year. In September 2017, the State Council issued the Opinions on Accelerating the Development of Cold Chain Logistics to Ensure Food Safety and Promote Consumption Upgrading, sending out supportive messages from the national policy level, thus ushering in the first climax of fresh e-commerce research in 2018. After a year of market shuffle, in 2019, the giants began to dominate the market, while small and medium-sized enterprises (SMEs) began to make their retreat. Since the global outbreak of the COVID-19 pandemic in 2020, fresh e-commerce has played an important role in safeguarding people’s livelihood and securing their daily necessities, which explains the upsurge in relevant research in the past two years.

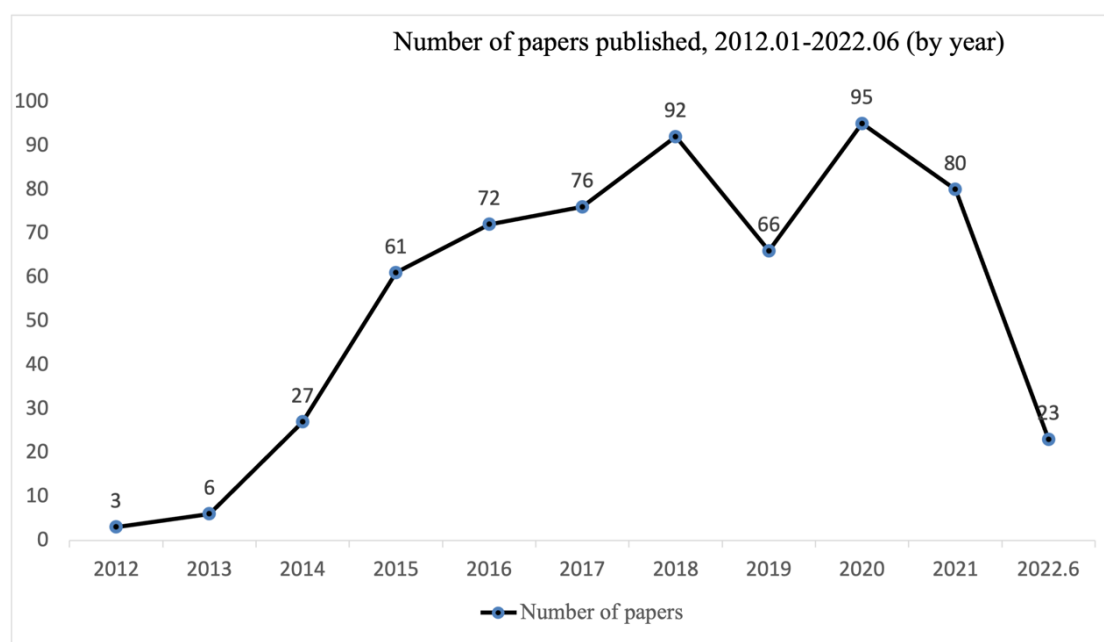


Figure 1: Number of papers on fresh e-commerce published from January 2012 to June 2022

The analysis of the distribution of journals allows for more details of the development of fresh e-commerce research from the fields involved and the scope of application. The results show that the 602 articles are published in 142 journals. Table 1 lists the top 10 journals with the most publications, of which China Food and Journal of Commercial Economics account for one quarter of the total publications. It is obvious that the field of research of fresh e-commerce publications is relatively extensive, and that there is a broad interest in such research from the academia, focusing on food, agriculture, commerce and logistics. A number of top journals have published related studies, though not in large quantities.

Table 1: Distribution of journals publishing articles on fresh e-commerce

Journal	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Account
China Food			4	10	18	13	11	8	14	3	2	83
Journal of Commercial Economics				2	7	17	13	11	8	9	2	69
China Journal of Commerce				9	7	4	2	4	4	4	2	36
Logistics Technology		1	1	5	4	3	5		6	6	1	32
Value Engineering				1		3	2	8	3	2	1	20
China Marketing	1		4	12								17
China Business and Market				1	2	2	2	2	2	5		16
Jiangsu Agricultural Sciences			1		1	2	3	4	1	1		13
Agricultural Economy				2			2	3	2	3		12
Journal of Anhui Agricultural Sciences			1	2	2	1			3	1		10
Economic Research Guide		1			1		2	2		1	2	9
Food Research and Development					1	1				2	4	8
China Logistics & Purchasing	1		1	1	5							8
Price: Theory & Practice									5	2		7
Jiangsu Commercial Forum				2	3	1					1	7
World Agriculture			1	2	2	2						7
Others	1	5	14	12	19	27	49	23	46	43	9	248
Account	3	7	27	61	72	76	91	65	94	82	24	602

Distribution of Subjects

The analysis of the distribution of subjects of fresh e-commerce research can help understand and further the application of this topic in various disciplines, as well as bring new application opportunities. This paper categorizes the 602 articles on fresh e-commerce in accordance with the Chinese Library Classification, as shown in Table 2. The distribution of subjects is divided into two categories: most of the research is distributed in agriculture, trade, enterprise, macro-management and other economic disciplines, while the other includes technical disciplines such as computer and industry.

Table 2: Distribution of subjects of fresh e-commerce research

Subject	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
Agricultural economy		3	10	31	27	34	39	18	32	19	8	221
Trade economy	2	2	10	12	28	22	25	31	29	32	6	199
Macroeconomic management and sustainable development	1	1	4	6	6	10	7	7	9	8	4	63
Enterprise economy			1	2		2	10	4	10	12	2	43
Computer software and computer application			1		2	3	2		3	1	2	14
Light industry and handicraft industry		1			1		3		1	2		8
Automation technology					3	1		2		1		7
Industrial economy			1	2			1		1			5
Mathematics							1	2		1		4
Fisheries and Fisheries				1	1				1	1		4
Others	0	0	0	7	4	4	3	1	8	5	2	34
Total	3	7	27	61	72	76	91	65	94	82	24	602

Of course, the distribution of subjects is not isolated. Nowadays, industries often integrate multiple disciplines, and so does the academic research. Fresh e-commerce research is multi-disciplinary in nature. Figure 2 demonstrates the interdisciplinarity of fresh e-commerce literature, where four disciplines – trade and economic, macroeconomic management and sustainable development, agricultural economy, and market research and information – have the most evident interdisciplinarity feature, and other disciplines also show some interdisciplinarity signs. It is the participation and engagement of researchers with different disciplinary backgrounds that enrich the disciplinary system and theoretical research of fresh e-commerce, which gradually evolves into a set of supporting system and guiding ideology both in theory and practice.



Figure 2: Interdisciplinarity of fresh e-commerce

Table 3: Keyword centrality

Keyword	Centrality	Count	Year
Consumer	0.61	30	2013
Fresh products	0.53	69	2012
Supply chain	0.45	37	2015
Fresh e-commerce	0.41	253	2012
SF express optimization	0.40	8	2012
Cold chain logistics	0.33	67	2014
Amazon	0.31	3	2012
E-commerce	0.29	89	2013
Optimization strategy	0.24	3	2017
o2o	0.23	16	2014

Keyword Clustering

To further explore the popular research areas in fresh e-commerce, the log-likelihood ratio (LLR) test in CiteSpace is selected to cluster the keywords, which helps identify the subject matter and general direction of fresh e-commerce research. The top 10 categories are obtained after summarizing and clustering the keywords, as shown in Figure 4. In addition, Table 4 lists the top terms contained in the clusters, each with an S value above 0.9, indicating that the clustering structure is reasonable. S value refers to the mean silhouette value, which is a parameter used to evaluate the clustering effect by measuring the consistency of network clustering. The clustering result is acceptable when the S value is greater than 0.5. The mean silhouette value of this paper is 0.9723, proving the goodness of overall clustering results. After a thorough study of the collected literature, we decide to categorize the 10 clusters into 3 types of research: research on the development of e-commerce platforms, research on fresh product safety, and research on cold chain logistics strategies. The analyses are as follows.

1) Research on the development of e-commerce platforms. There are four sub-categories within this research: fresh e-commerce, new retail, e-commerce and e-commerce platform. The discussion on the e-commerce model, model innovation in the context of new retail, and platform models of fresh e-commerce have always been popular research topics. Wang (2018) divided fresh e-commerce into four types: the platform type represented by Tmall, the vertical type represented by Tootoo.com, the O2O type represented by Yonghui superstores, and the new retail type represented by Hema Fresh. Canavari et al. (2010) analyzed the differences between fresh e-commerce and traditional retail of fresh produce, and discussed the way to establishing a credibility system to improve its reliability value with regards to business models and operation strategies. Taking into consideration the new retail and the impact from COVID-19, He summarized four major changes in the business model of China's retail enterprises: deep online, socialization and fragmentation, the trend of "unmanned", and platform.



Figure 4: Keyword clustering

2) Research on fresh product safety. Three clusters are included in this category: fresh product, quality and safety, and influencing factors. Fresh products are regarded as the barometer of "people's living standard and quality". They occupy a certain portion in people's daily food consumption, and people are paying increasing attention to their quality and safety (Shen

& Liang, 2021). In China, the loss rate of vegetables and fruits during circulation is 25%-30%, causing a loss of more than 150 billion yuan every year (Wang & Chen, 2017). The business of fresh e-commerce is consumers' consumption of fresh products, and freshness is a key factor affecting their decision to buy those products (Joseph & Gary, 2009; Liu et al., 2020). Some studies have shown that freshness determines the core competitiveness of fresh product companies (Liu et al., 2021), and that the quality and safety of fresh products is of vital importance to the development of the industry.

3) Research on cold chain logistics strategies. This category contains three clusters: cold chain logistics, supply chain and circulation mode. The construction of cold chain logistics infrastructure lies at the core of fresh e-commerce industry. The integration of supply chain resources and the construction of cold chain logistics are two unavoidable challenges for fresh e-commerce enterprises. As early as 2012, Govindasamy delineated the importance of management and maintenance of the supply chain in the fresh e-commerce market (Pouratashi, 2012). Fresh products are perishable and have a short shelf life (He et al., 2019), and the low temperature provided by cold chain can keep their quality and freshness to the fullest extent possible (Zhang, 2016). A number of scholars have studied the cold chain logistics infrastructure of fresh e-commerce. Lan and Tian's research (2013) showed that the imbalance between the higher demands of fresh food and the lower capital facilities reflected one of the constraints on fresh food e-commerce, i.e., shortage of the cold chain logistics. Guritno et al. (2015) studied the influencing factors affecting the performance of the fresh product supply chain from the supply chain perspective and proposed different inventory management strategies for unique and common fresh products. To address the issue of cold chain localization, Jiang et al. (2021) studied the sustainable management of logistics services of fresh e-commerce in the context of COVID-19, and pointed out that the core task of fresh food e-commerce companies was to improve the quality of logistics services based on customer satisfaction.

Table 4: Keyword clustering

ID	Name	Size	Silhouette	Top Terms
0	Fresh e-commerce	71	0.998	fresh e-commerce, development model, double eleven, mode, evolutionary game, moral hazard, new consumption
1	Fresh product	50	0.98	fresh agricultural products, fresh products, purchasing intention, restrictive factors, driving force, fresh food management
2	Circulation mode	46	0.97	cold chain circulation, hema fresh, supply chain management, optimization strategy, third-party logistics distribution mode
3	Supply chain	35	0.969	supply chain, logistics distribution, novel coronavirus pneumonia epidemic, bayesian network, o2o operation, distribution route
4	Influencing factors	33	0.99	influencing factors. supply chain coordination, quality and safety, e-commerce of agricultural products, aquatic products, promotion effort level, preservation effort
5	E-commerce platform	28	0.978	e-commerce platform, fresh food market, food supply chain, food logistics, food community, e-commerce operation mode
6	E-commerce	27	1	e-commerce sales, fresh e-commerce, mobile internet. information technology, internet marketing, business ecosystem , mobile internet
7	New retail	27	0.985	new retail, genetic algorithm, community fresh food, particle swarm optimization algorithm, development strategy, business scene
8	Cold chain logistics	22	1	cold chain logistics, swot, vacuum precooling, two-way circulation, joint distribution, double circulation
9	Quality and safety	19	0.982	food safety, internet plus, service quality evaluation, fresh online shopping, cold chain logistics of agricultural products, consumption upgrade, quality and safety

ANALYSIS OF RESEARCH TRENDS

Burst detection in CiteSpace has supported this paper in analyzing the research trend of fresh e-commerce. The burst terms are detected from a large number of keywords by analyzing the temporal distribution of term frequencies. Rather than solely relying on the frequency level, it also draws upon the changing trend of term frequencies to identify the frontier research trends of fresh e-commerce. First, timeline analysis is used to uncover the evolution paths and the changing trends of keywords in each cluster, which sets the scene for exploring the development directions. Then, by combining the burst terms with relevant

national policies, the paper divides the development of fresh e-commerce into three stages: rapid development (2012-2015), exploration and transformation (2016-2019), maturity and upgrade (2020-present).

Timeline Analysis

Timeline analysis can visualize the evolution of the keywords in each cluster across a number of time sliced intervals, so as to analyze the trends and development directions of fresh e-commerce research. As shown in Figure 5, the larger the size of a node, the more popular the research. The link represents the evolution of the research topic over time, and the solid and dotted horizontal lines indicate the continuity of the research hotspots. The research on fresh e-commerce, fresh product and quality and safety has lasted from 2012 to 2022, while the research on new retail continues from 2017 to 2022. Cold chain logistics and circulation mode have been popular research topics from the beginning, and will keep their momentum in the future. Fresh e-commerce and fresh product became research hotspots in 2012, and that opportunity for e-commerce, cold chain logistics, supply chain, and new retail came in 2013, 2014, 2015 and 2017, respectively. The research trends in recent years can be found in Figure 5. After the pandemic hit in 2020, freshness-keeping efforts and end distribution have become the foci of research, and the government has stressed the need to improve “last mile” facilities in fresh e-commerce. As the pandemic control and prevention measures have become normalized, the studies on status, marketing, perceived value and community are expected to become the hotspots and trends in the mature upgrading stage of fresh e-commerce.

Burst Terms and Policy Analysis

Burst term is the keyword word or terminology that suddenly sees an increase in occurrence or citation frequency, or growth rate, in a short period of time. The stronger the burst, the more it can represent the latest developments and trends in that period of time. Prof. Chen Chaomei, developer of Citespace software, believes that burst keywords can explain the frontier issues in a certain discipline (Chen, 2004). This paper has detected the top 20 Keywords with the strongest citation bursts, as shown in Figure 6. Combining them with the publication trend in Figure 1, the evolution paths of fresh e-commerce research in Figure 5, as well as national policies, the paper divides the development of fresh e-commerce into three stages: rapid development (2012-2015), exploration and transformation (2016-2019), maturity and upgrade (2020-present).

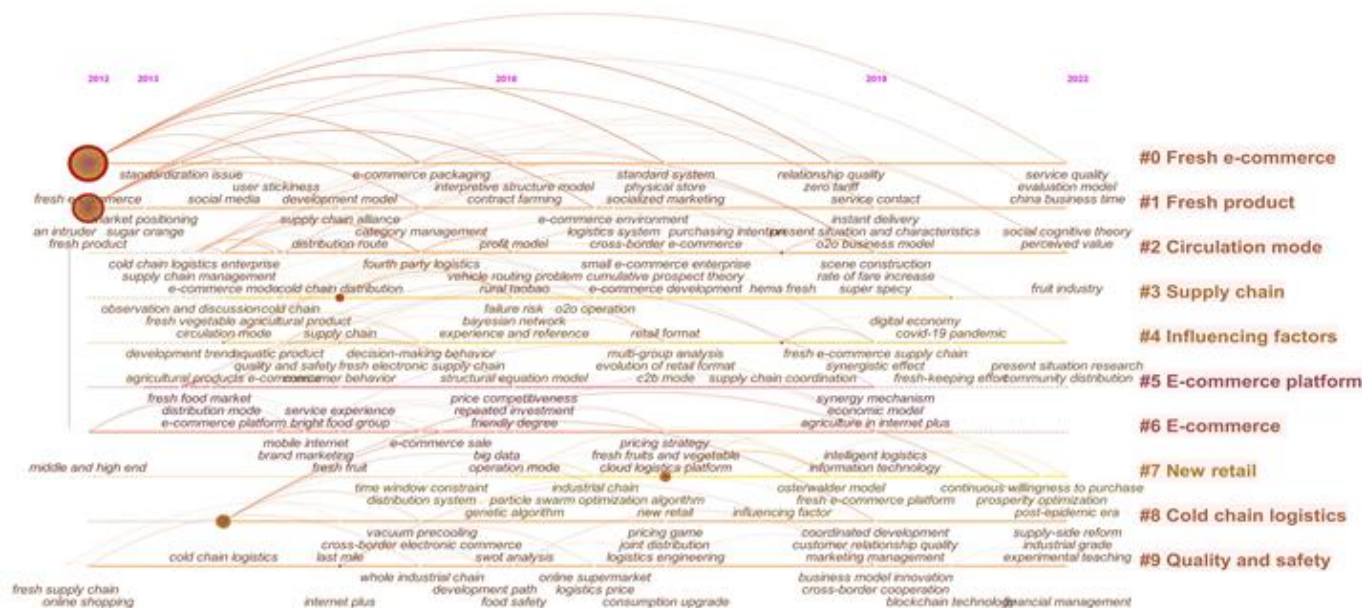


Figure 5: Evolution paths of fresh e-commerce research

Top 20 Keywords with the strongest citation bursts

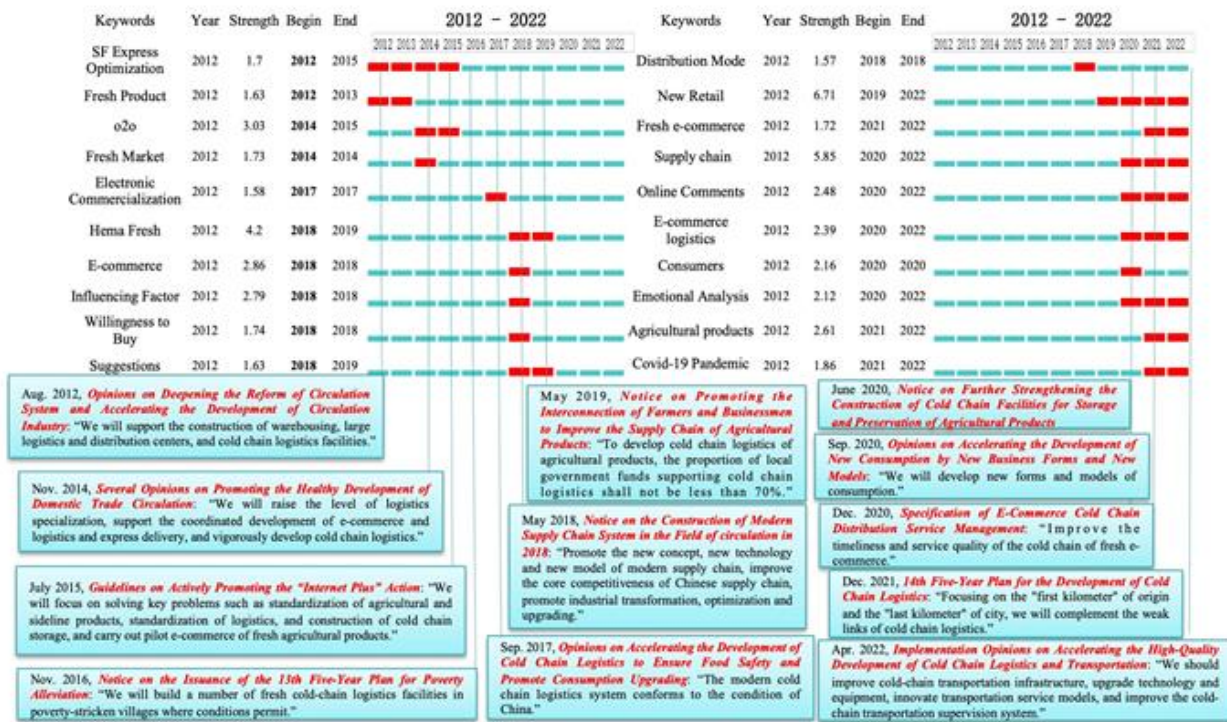


Figure 6: Keyword bursts

Rapid development (2012-2015): Burst terms in this period include Shunfeng (SF) Express Select, fresh products, O2O and fresh food market. The strongest burst of O2O is 3.03. It was a period when O2O was growing fast, and SF Express, taking advantage of its own logistics, warehousing and stores, rode on the wave of O2O and fresh e-commerce, and launched SF Express Select. In 2012, the State Council issued the *Opinions on Deepening the Reform of Circulation System and Accelerating the Development of the Circulation Industry*, pointing out the need for the nation to speed up the construction of industrial circulation, in particular, the circulation of fresh products represented by agricultural products, which were counted as strategic materials. Subsequently, the *National New-type Urbanization Plan (2014-2020)* proposed "speeding up the cultivation of modern circulation modes and new forms of circulation, vigorously developing fast and efficient distribution, accelerating the development of e-commerce of agricultural products, and reducing circulation costs". In addition, the No. 1 Central Document issued in 2015 pointed to the necessity of transforming and innovating the circulation mode of agricultural products and strengthening the construction of transporting channels for agricultural products. Undoubtedly, these policies provided unprecedented support and development opportunities to the O2O model of fresh e-commerce. However, scientific research on O2O still faced numerous problems and bottlenecks that needed to be dealt with. Liu and Walsh (2019) held that O2O referred to combinations of business opportunities from both offline and the Internet and it made the Internet into a new trading platform. The huge number of orders and the time crunch for order fulfilment would affect the movement of goods. This would lead to the last-mile logistics being one of the "most inefficient and most expensive" part of the supply chain (Fernie et al., 2010). Hong et al. (2019) insisted on combining O2O and localization. Fresh e-commerce was characterized by the trend to localize, and the combination of e-commerce enterprises with local farms and offline communities. SMEs of fresh e-commerce boomed in this period, and logistics distribution became the bottleneck in their businesses. Based on the three original logistics modes, some scholars put forward the new mode of "third-party logistics + consumer pick-up / third-party delivery" to help solve the logistics problems of SMEs.

Exploration and transformation (2016-2019): Burst terms in this period include electronic commercialization, Hema Fresh, e-commerce, influencing factors, willingness to buy, advice, distribution modes, online and offline and new retail. The burst strengths of Hema Fresh and new retail are 4.2 and 6.71 respectively. It was a period when the industry gradually reach maturity, and when rural e-commerce achieved notable growth. The No. 1 Central Document issued in 2016 proposed to accelerate the development of rural e-commerce and form a two-way circulation pattern of online and offline integration, with which agricultural products could go into cities and agricultural materials and consumer goods to the countryside. The document also urged innovation of the circulation mode of agricultural products through e-commerce. In the context of the new retail, Hema Fresh, relying on the endorsement from Alibaba, adopted the new model of "one store, two warehouses and five centers" that integrated online and offline marketing, and achieved great success. During this period, the research began to move towards diversification, promoting the integration of "Internet +" with fresh products and selling fresh products with e-commerce. In terms of distribution, Li argued that under the background of new retail, the traditional logistics and supply mode of fresh product should be changed into a decentralized one, and distributive storage should be established to realize modern distribution (Qin, 2019). In terms of consumption habits, as consumers were used to consuming fresh products offline,

how to enhance their willingness to buy online and exploring the influencing factors of their purchases became the foci of research. By analyzing the mode of “organic + community distribution” of the Japanese fresh e-commerce company Daichi, some scholars put forward their thoughts on how to change the consumption habits of Chinese consumers, improve quality and ensure safety of agricultural products, increase the number of buyers and their online purchase stickiness, as well as establish trust between the production and the marketing sectors.

Maturity and upgrade (2020-present): Burst terms in this period include new retail, supply chain, online reviews, e-commerce logistics, consumers, sentiment analysis, agricultural products and COVID-19. The burst strength of supply chain is 5.85. Following the market shuffle in the transformation period, the giants began to dominate the market, while SMEs closed down, with a survival rate of less than 10%. As a result of the pandemic hit, consumers shifted to online purchase, which led to a continuing growth in online shopping and fresh e-commerce. Lockdowns in cities became common due to pandemic control and prevention, exposing the weakness of the supply chain. For example, Shanghai experienced a supply chain shortage along with rocketing prices. To ensure that the fresh e-commerce supply chain was stable, the government issued the *Notice on Further Strengthening the Construction of Cold Chain Facilities for Storage and Preservation of Agricultural Products* in 2020, the *14th Five-Year Plan for the Development of Cold Chain Logistics* in 2021, and the *Implementation Opinions on Accelerating the High-Quality Development of Cold Chain Logistics and Transportation* in 2022. To unveil to what extent consumers had shifted to online food shopping during the pandemic, Chang and Meyerhoefer (2021) found that an additional confirmed COVID-19 case increased the sales by 5.7% and the number of customers by 4.9%. The greatest demand increases were found in grains, fresh fruit and vegetables, and frozen food. Some scholars used weighted classification to measure the format of fresh e-commerce before and after the pandemic, and found that the attention on fresh e-commerce was barely noticeable in the early stage of the pandemic, partly because it ran into bottlenecks, and partly because consumers’ attitudes created strict requirements for the supply chain. In the later stage, however, environmental factors offered the opportunity for fresh e-commerce to develop, and the attention on it was rising unceasingly. Online reviews, shopping experience and product quality are not only the foci of consumers, but also of researchers. By revising the index system for evaluating the quality of logistics service, Chen et al. (2021) put forward an evaluation system that covered six dimensions: security, timeliness, economy, pleasantness and convenience.

CONCLUSION

In the context of the normalization of the epidemic, people's consumption habits are accelerating towards online, and consumers' consumption concepts about fresh products are starting to change. In economically developed cities, fresh e-commerce has become a habit of white-collar workers, especially the business model of community group buying. It is very popular among consumers for its affordable price, ease of purchase and quality assurance. Fresh e-commerce not only promotes the construction of fresh produce supply chain and accelerates product circulation, but also improves people's quality of life.

In this paper, a total of 602 articles on fresh e-commerce research, retrieved from CNKI, CSSCI, Wanfang and VIP, are selected as the databases. A current situation analysis is conducted to count, classify and compare these articles from three dimensions – the year of publication, article sources, and distribution of subjects – to sort out the research status of the literature on fresh e-commerce. CiteSpace is then used to perform a bibliometric analysis of the data and to create visualized knowledge maps, and the following conclusions are drawn.

With respect to literature and subject distribution, in 2012, the “first year of fresh e-commerce”, research on fresh e-commerce was only in its infancy. Its heat began and kept rising after being named the “last blue ocean” of e-commerce and receiving strong policy support from the government. Fresh e-commerce covers a wide range of research fields, and therefore has attracted broad interest from the academia. More articles are published in journals on food, agriculture, commerce and logistics. Most of the research is dispersed in agriculture, trade, enterprise, macro-management and other economic disciplines, while the other is distributed in technical disciplines such as computer and industry. What’s more, the highly interdisciplinary nature of fresh e-commerce also contributes to the richness of its disciplinary system and theoretical research.

Through analyses of keyword co-occurrence network, keyword centrality and keyword clustering, we can have a clearer picture of the research content and hotspots in the field of fresh produce e-commerce. There are several larger nodes in the keyword co-occurrence network, such as e-commerce, cold chain logistics, supply chain, new retail, O2O, business model and fresh products, suggesting that more research is conducted in these areas, and that they are the research hotspots. Centrality can reflect the importance of the keywords in the network, as well as their intermediary roles and influence. In general, the research hotspots of fresh e-commerce focus on consumers, fresh products, cold chain logistics, e-commerce, O2O, supply chain and new retail. To further expand our exploration of the research hotspots of fresh e-commerce, keyword clustering is used to summarize the research directions. After the clustering, the top 10 clusters are categorized into 3 types of research: research on the development of e-commerce platforms, research on fresh product safety, and research on cold chain logistics strategies. Clustering helps identify the subject matter and general direction of fresh e-commerce research.

The environment in which fresh e-commerce develops is different in each period. The research trends have made the progress from the infrastructure construction of cold chain to the innovation of business models, and to the optimization and upgrading of services. Combining the publication trend in Figure 1, the evolution paths of fresh e-commerce research in Figure 5, the

burst terms in Figure 6, as well as national policies, the development of fresh e-commerce is divided into three stages: rapid development (2012-2015), exploration and transformation (2016-2019), maturity and upgrade (2020-present). At each stage, the research evolves toward diversity and maturity with policy developments and changes in the external environment. At present, COVID-19 has brought a critical and unprecedented opportunity for the development of fresh e-commerce, and the bottleneck and problem it faces have changed from infrastructure construction to upgrading and optimization. The logistics industry is developing towards intelligent logistics park and intelligent logistics platform (Liu, 2020). Aided by blockchain, optimized smart distribution will become the future development trend and the commanding point of competition of the fresh agricultural products logistics industry (Li et al., 2022). Fresh e-commerce enterprises should make the most of new technologies such as big data analysis, cloud computing and artificial intelligence to gradually improve the standardization process of fresh agricultural products, improve consumers' satisfaction of their experiences, and predict future market trends of the consumption of fresh agricultural products (Wei, 2021). In addition, as the consumer market is unstable, fresh e-commerce enterprises should improve quality and service models, deeply explore different consumers' preferences, and constantly improve their business models with new retail, to stabilize the consumer market.

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Research on agricultural supply chain finance supporting sustainable poverty reduction under the background of digital technology

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ABSTRACT

From the perspective of financial services, management services and coordination services, this paper analyzes the internal mechanism of agricultural supply chain finance (ASCF) to help sustainable poverty reduction (SPR). The internal and external driving forces of ASCF for SPR are also explored. Among them, the internal driving forces include industrial upgrading and financial transformation; External driving forces include technological change, policy guidance and market drive. Based on the background of digital technology, the green agricultural supply chain finance (GASCF) model has been innovatively proposed. We mainly analyze the core elements and platform structure of GASCF, and focus on the process design and key points of the three modules of the GASCF platform: risk control port, credit port and capital port. Finally, we analyze the practical difficulties of green agricultural supply chain finance in helping sustainable poverty reduction, such as the lack of comprehensive management ability of the organization, the insufficient application of digital technology, the imperfect institutional environment and the lack of compound talents. And we put forward accordingly a four in one path of GASCF helping SPR, which is "Government standardizing and leading, assistance from financial institutions, driven by industry subjects and Co governance of Social Service".

Keywords: Agricultural supply chain finance, Green development, Sustainable poverty reduction, Digital technology.

INTRODUCTION

Since the reform and opening up, with the continuous improvement of China's agricultural support policy system and the continuous increase of the policy of strengthening agriculture, benefiting agriculture and enriching agriculture, the comprehensive agricultural production capacity has achieved great development. However, compared with industry and manufacturing, the growth rate of agricultural added value is still low, and its proportion in GDP has decreased significantly. This is not only related to the adjustment, optimization and upgrading of national industrial structure, but also reflects the relatively low agricultural labor productivity in China, which makes the development of agricultural economy slow and lag for a long time, and has become an important weakness restricting the goal of building a moderately prosperous society in an all-round way. Agricultural development is subject to many factors, among which credit constraints are one of the key factors that restrict the development of rural economy, the upgrading of agricultural industrial structure and the increase of farmers' income, while the lack of qualified collateral and high credit risk uncertainty are the important reasons for agricultural credit constraints. The important purpose of ASCF operation is to rely on the reputation of the focus enterprises in the agricultural supply chain (ASCF) to help agricultural small and medium-sized enterprises or farmers obtain financial services. As an important mode of combining industry and finance, ASCF, with its unique advantages of being close to the agricultural chain, effectively makes up for the defects of traditional agricultural finance by using the pledge of movable assets such as means of production and grain embedded in the agricultural chain trading network and the credit guarantee of agricultural focus enterprises.

However, cofas' 2022 China enterprise payment survey shows that the credit period of China's agricultural enterprises in 2021 was as high as 88 days, and the number of days of overdue payment increased by 43 days compared with 2020. The number of agricultural enterprises with ultra-long overdue payment (more than 6 months) accounting for more than 10% of turnover increased from 27% in 2020 to 40% in 2021, Whether the number of days of overdue payment or the proportion of ultra-long overdue payment is more worrying in many industries. This shows that there is a wide structural gap in the financial supply pattern of the ASC, and there are still a large number of long tail small agricultural enterprises and farmers. At this stage, the implementation of ASCF has also begun to expose some difficulties and pain points, such as the lack of agricultural focus enterprises, weak agricultural credit system, low degree of standardization of agricultural products, weak ASC (Xu & Zhang, 2020; Shi *et al.*, 2020), which restrict the effective operation of ASCF, leading to the unsatisfactory effect of agricultural poverty alleviation in some regions, and the return to poverty phenomenon of "financial poverty alleviation without poverty reduction" is still emerging. The ASCF operation mode relying on the endowment advantages of different leading parties has heterogeneity, and there are great differences in poverty reduction mechanism and poverty reduction effect (Shen *et al.*, 2020), which limits the universality and promotion value. At present, there is an urgent need to innovate the ASCF service model,

provide more small-scale agricultural enterprises and farmers with efficient, accurate and cheap financial services, and improve the sustainability of financial poverty reduction.

ASCF is the application of supply chain finance (SCF) in the agricultural field. Relying on the advantageous resources of core enterprises, it breaks through the weak credit of small and medium-sized agricultural enterprises and farmers in the agricultural chain and solves the financial constraints of the agricultural chain. In recent years, the operation mechanism, operation mode and poverty reduction effect of ASCF have attracted scholars' attention. On the operation mechanism of ASCF. The earliest prototype of ASCF can be traced back to the "grain warehouse receipts" that appeared in Mesopotamia in 2400 BC (Breckwoldt, 1995). Modern ASCF mainly relies on various financial platforms, with core enterprises as the leading role, to provide financing services for members of the ASC. Shen *et al.* (2019) took cooperatives as the research object, used the double difference method to design the model, deeply compared and analyzed the operation mechanism of ASCF models in different regions and different core agricultural entities, and deeply explored the multi-party cooperation mechanism between entities.

On the development of digital technology and SCF mode. The development of SCF in China has roughly experienced the evolution process of financial orientation, supply chain orientation and network ecological orientation (Song, 2020). The SCF mode at different stages has played an important role in solving the financing difficulties of industrial enterprises by relying on the inherent resources or comparative advantages of the organization in financial professional services, controlling the supply chain business links or controlling the transaction information of the system. Under the influence of the new generation technology, SCF has developed to the digital stage. Based on information technology, innovative models such as Internet SCF (Song & Chen, 2016), smart SCF (Song & Yang, 2019) digital SCF (Dou *et al.*, 2020), blockchain +SCF (Gong *et al.*, 2021) and Internet of things +SCF (Gong *et al.*, 2017) have emerged. The integration support of technology provides a huge opportunity for the innovative development of SCF model.

Research and Practice on the financial operation mode of ASC. Foreign mainstream ASCF models mainly include: ASC enterprises and P2P cooperation model represented by the cooperation between Danish food retailer coop and P2P platform myc4; Farmers' public welfare P2P lending represented by Kiva in the United States; Commercial lending represented by Zopa in the UK, prosper in the US and lending club (Xu, 2015). Wang *et al.* (2013) Pointed out that agricultural product supply chain enterprises can obtain funds through pledge financing of orders, accounts receivable and prepayments. In recent years, with the implementation of the targeted poverty alleviation policy and the development of Inclusive Finance, Chinese scholars have carried out research on ASCF, and put forward ASCF service models led by rural commercial banks (Guan, 2011), farmers' cooperatives (Shen *et al.*, 2019), insurance institutions (Liu & Cheng, 2013) agricultural parks and trust institutions (Guo *et al.*, 2020). The operation of this kind of mode mainly relies on the resource endowment or comparative advantages of the organization in financial professional services, control of agricultural chain business links, improvement of credit guarantee or panoramic control of supply chain transaction process, which played an important role in promoting the early poverty alleviation. At present, many domestic scholars mostly use the case analysis method to study the typical ASCF models in different regions, such as the "wuliming" model of Heilongjiang Longjiang bank (Guan, 2011) and the financing model of Zhejiang agricultural whole industry chain (Tian, 2018). Shaoxian took the SCF of Mawangdui vegetable wholesale market as the research object, and proposed different modes to meet the capital needs of production links and private brokers and market merchants (Shao, 2013). Ma Yingjie and others took the SCF of the traditional Chinese medicine industry in Anguo as the research object, and proposed the ASCF model with professional cooperatives, traditional Chinese medicine trade centers, and retail investors in the cultivation of traditional Chinese medicine as the financing subjects (Ma & Wu, 2017). Guo Jienian analyzed the typical models of ASCF such as "agricultural enterprises + financial institutions + farmers, agricultural enterprises + cooperatives + financial institutions + farmers, agricultural enterprises + agricultural parks + financial institutions + farmers (Guo *et al.*, 2020).

There are few studies on the poverty reduction effect of ASCF, and most of the existing studies focus on financial poverty reduction. As an important poverty reduction and enrichment mechanism in China, the improvement of the index of digital finance can significantly reduce the probability of poverty in families (Zhang & Li, 2022). At the same time, digital finance can improve the efficiency of economic growth, promote fair income distribution, and continue to play the effect of poverty reduction and income increase (Li & Peng, 2022). The poverty reduction of ASCF is a specific implementation measure of financial poverty reduction. As a new financing mode, ASCF plays an important role in actively promoting financial poverty alleviation, connecting small farmers with large markets, and supporting rural revitalization and development (Shen *et al.*, 2019). Dai *et al.* (2022) proposed that ASCF can promote the increase of farmers' income and the decrease of Engel's coefficient, and the poverty reduction effect in the central and western regions is more obvious than that in the eastern region; The intermediary effect of production scale and urbanization rate in improving farmers' income level in ASCF is obvious, while only the intermediary effect of urbanization rate in reducing Engel's coefficient in ASCF is obvious.

From the financing difficulties of agricultural enterprises, the defects of traditional agricultural finance, the difficulties in promoting the three rural policies, and then to the innovative application of SCF in the agricultural field, the research on solving the problem of agricultural financing has been extended in breadth. However, the SPR effect of ASCF has not attracted widespread attention. At present, there is an urgent need to conduct in-depth research from the following aspects: first, analyze the internal mechanism of ASCF to help SPR, and study the dynamic mechanism of ASCF to help SPR from the perspective of external power and internal power, which is a relatively scarce aspect of existing research; Secondly, combined with the digital

ecology theory and the deployment of double carbon strategy, innovate the GASCF model based on SPR; Third, starting with the practical dilemma that restricts the SPR of ASCF, we should seek a feasible path to solve the dilemma, which is a powerful supplement to the existing research.

Therefore, based on the analysis of the internal mechanism and dynamic mechanism of ASCF to promote SPR, this study puts forward the model innovation of GASCF to promote SPR, further analyzes the possible challenges of ASCF innovation model to promote SPR at this stage, and then constructs the path of ASCF to promote SPR.

THE INTERNAL MECHANISM OF ASCF SUPPORTING SPR

Based on the integration and application of digital technology, this section analyzes the internal mechanism of SPR in ASCF from the perspective of financial services, management services and coordination services. First, with the strong support of the digital service system, we should give full play to the financial service function of ASCF to provide more dragon tail enterprises with accurate, efficient and cheap financial services. Secondly, based on the forced mechanism and the introduction mechanism, the management function of ASCF is applied to guide the investment projects of agricultural industry chain towards low-carbon and environmental protection, and more low-carbon agricultural enterprises with good development potential are brought into the ASCF ecosystem to promote the low-carbon transformation of agricultural enterprises. Third, introduce digital ecology, build a digital financing platform, realize the coordinated operation of material flow and capital flow in the low-carbon supply chain through data information sharing, give full play to the comprehensive coordination function of ASCF, and maximize the overall income of the ASC.

Innovate financial services and promote the stable development of ASC

ASCF can make up for the financing gap of agricultural green development by gathering capital advantages, promoting the reconstruction of traditional models and the innovation of new models. With the application and development of digital technology, ASCF can innovate the traditional ASCF modes such as prepayments, accounts receivable and inventory pledge under the support of the integration of new generation technologies such as big data, blockchain, Internet of things and artificial intelligence, and use digital technology to improve the payment and settlement in the SCF trading platform in combination with the advantageous resource status of different node institutions in the ASCF platform. The design of core modules such as credit management and fund management innovates and reconstructs the operation process of the ASCF model under different application scenarios, as well as the layout of key points such as the estimation of the value of the pledge of enterprises with insufficient funds, the credit evaluation of participants, and the release and recovery of funds from the supply chain platform. At the same time, according to the service orientation of the industrial system of the national financial supply side structural reform, aiming at the characteristics of "asset light, capital light and technology heavy" of the industrial system such as agricultural science and technology-based small and micro enterprises or agricultural low-carbon small and micro enterprises, combined with the penetration and application of digital technology, innovative designs are made for the key control points such as the value evaluation of intangible assets, the pledge of the usufruct of intangible assets, and the self-repayment of intangible asset transfer fees. Build a digital SCF innovation model based on the pledge of intangible assets such as intellectual property rights or carbon rights. Through the reconstruction of traditional mode and the development of new mode, we can give full play to the financial service function of ASCF and promote the stable development of ASC.

Play a management role and promote the low-carbon transformation of ASC

For the first time, China made a strong declaration of the "double carbon" goal, describing a blueprint for achieving green, low-carbon and high-quality development in the future. Accelerating the green development of agriculture is of great significance to promote China to achieve the double carbon goal. At this stage, ASCF should rely on the advantages of close connection with the industrial chain, maximize the application of agricultural new infrastructure dividends, gather all kinds of risk control, credit enhancement and capital advantage resources or capabilities, give full play to the management function, promote the low-carbon transformation of ASC, shape the green competitiveness of agricultural chain, and promote the sustainable development of ASC. The function of ASCF management can form an effective "forced mechanism", gradually eliminate heavy industry, non-low-carbon agricultural projects or enterprises from the system, and guide agricultural investment projects towards low-carbon and environmental protection. In addition, the ASCF management function can also be used as an incentive means to introduce more agricultural science and technology enterprises and agricultural low-carbon enterprises with good development potential into the system through a good introduction mechanism, stimulate the driving force of industrial chain upgrading, enhance the tension of agricultural enterprise development, force a new turning point in energy conservation, environmental protection and circular economy, enhance the initiative of agriculture to get rid of poverty and promote SPR.

Optimize the coordination function and improve the comprehensive performance of ASC

At present, the problem of "small scattered" and the contradiction and conflict between the old and new production capacity conversion are common in China's agriculture. Market transactions have caused high transaction costs in the whole agricultural chain. Among them, the capital squeeze of leading enterprises in the supply chain on the upstream and downstream small and medium-sized agricultural enterprises or farmers based on their own interests maximization is an important reason for the high transaction cost of the industrial chain, which intensifies the turbulence and danger of the operation of the supply chain industrial chain. In 2020, eight ministries and commissions jointly issued the opinions on standardizing the development of SCF to support the stable circulation, optimization and upgrading of the supply chain industry chain, which made it clear that

we should promote the scenario and ecology of SCF, improve the online and digital level, and improve the operation efficiency of the supply chain industry chain, fully indicating that the state attaches great importance to the normative solution of industrial structural investment and financing conflicts at this stage. Therefore, it is very urgent and important to give full play to the comprehensive coordination function of SCF and optimize the transaction cost of agricultural chain. Striving to create an open, healthy and safe digital ecosystem is an important strategic task for China to accelerate the construction of a network power and a digital China in the "14th five year plan" and the medium and long term, and to promote high-quality economic and social development. With the accelerated penetration of new technologies, new formats and new models in the field of ASCF, a large number of heterogeneous organizations such as agricultural enterprises, producer services and government agencies will form a value cycle system of symbiosis, build an industrial integration mechanism of data connectivity, and different economic entities will enter the ASCF ecosystem platform across regions and systems. Based on the overall thinking of the industrial chain, the platform integrates the Internet, big data, artificial intelligence and other new generation technologies, and based on the symbiosis theory in ecology, considers the symbiosis needs of collaborative subjects, optimizes the relationship of multi-agent symbiosis, improves operation efficiency, reduces financial costs, improves the comprehensive income of ASC, and promotes the SPR of ASC.

DYNAMIC MECHANISM OF ASCF supporting SPR

According to the internal logic of "motivation behavior", the driving mechanism of SPR in ASCF includes two systems: external driving force and internal driving force.

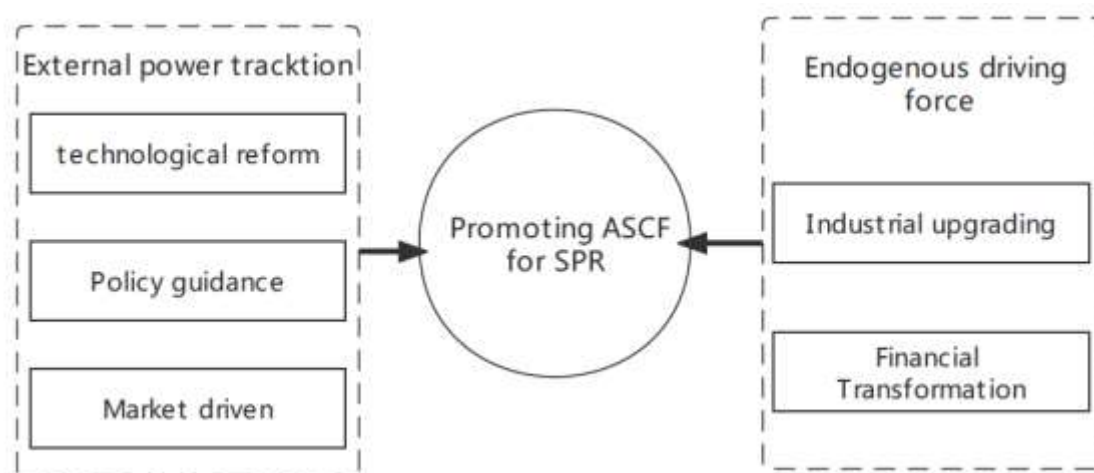


Figure 1: Dynamic mechanism of ASCF for SPR

Exogenous power

New opportunities: technological change reshaping the development mode of ASCF

In the past, ASCF has been in the traditional "extensive" development for a long time, with imperfect credit evaluation system, weak risk control mechanism, scattered collateral of small agricultural enterprises and farmers and lack of collateral types, leading to financial institutions unwilling to develop corresponding financial products and services for ASC; Logistics companies that control the operation of ASC lack digital platforms, which limits the financial assistance of the ASC to SPR. With the development of digital technology, Internet, big data, artificial intelligence and other technologies have promoted the formation and development of the digital ASCF platform, promoted the data sharing and commonality among the participants in the ASC, exchanged data for credit, improved the digital credit and risk control system, and integrated third-party service institutions such as logistics companies, asset evaluation institutions, public service institutions into the ASCF platform, Undertake the social responsibility of low-carbon emission reduction, reduce the operation cost of ASC, improve the economic benefits of the participants in ASC, and promote ASCF to help SPR.

New policy: policy guidance to ensure the stable development of ASCF

Since the 19th CPC National Congress, the issue of "agriculture, rural areas and farmers" has been the top priority of the work of the whole party, and it is also an urgent problem to be solved in the implementation of Rural Revitalization and poverty eradication. The State Council issued the national agricultural modernization plan (2016-2020), which pointed out that we should continue to innovate financial policies to support agriculture and strive to improve the level of sustainable agricultural development. The 14th five-year plan mentioned that we should give priority to the development of agriculture and rural areas and comprehensively promote rural revitalization. In combination with the spirit of the central economic work conference and the central rural work conference, the central bank proposed in the "opinions on doing a good job of financial support in 2022 and comprehensively promoting the key work of Rural Revitalization" that we should effectively increase financial support in the "three rural" areas, optimize the allocation of credit resources, continue to increase credit investment, and standardize the development of ASCF services. To ensure the stable development of ASCF, the guidance of policies should not be ignored. Reasonable ASC policies, give full play to the social responsibility of government departments, grasp the operation of ASCF

platform macroscopically, monitor the credit risk and moral hazard it can encounter, and force the development of ASC to move towards a green and low-carbon development path with policies.

New requirements: ASCF for SPR being market-driven

With the rapid development of China's economy and the increasing improvement of people's living standards, we are in the era of consumption upgrading. Consumers gradually begin to pay more attention to the quality of products and ignore the price of products. The upgrading of consumer demand has promoted the rapid development of the agricultural market. The digital ASCF platform integrates various public services including finance, logistics, communication, etc. on the one hand, it can efficiently provide fresh agricultural products for consumers and agricultural product processing enterprises, on the other hand, it can also ensure that agricultural products with short shelf life can flow into the market in a timely and intact manner. The agricultural products processing enterprises in the upstream of the supply chain are not all agricultural leading enterprises with strong economic strength. Most small agricultural enterprises are still the main force in the ASC, and these small and medium-sized agricultural enterprises lack sufficient funds to meet the consumption upgrading of the agricultural products market. Through the ASCF platform, we can efficiently realize resource allocation, specifically meet their personalized capital needs, and help them follow the tide of agricultural consumption upgrading.

Endogenous dynamics

Establish advantages: industrial upgrading breaking the bottleneck of agricultural development

In recent years, driven by a series of national policies, China's agriculture has developed rapidly. However, at this stage, there are still problems such as "small, scattered, chaotic and weak" in agricultural development. "Small" refers to the small scale, small input and small output of the participants in the agricultural industrial chain, and even some small farmers have only a few acres of cultivated land; "Scattered" means that in the agricultural industry, there are few links between small farmers and agricultural enterprises, financial institutions serving agriculture and other subjects, so it is difficult to play a synergistic role; "Chaos" means that the disorderly competition in the agricultural industry is serious, and the party with information and capital advantages in the agricultural industrial chain has malicious behavior of raising, lowering and disturbing market prices, resulting in the damage to the rights and interests of small farmers and small and medium-sized agricultural enterprises; "Weak" refers to the weak overall ability and low competitiveness of the agricultural industry. The upgrading of agricultural industry is a sharp sword to solve the problems of "small, scattered, chaotic and weak" in China's agricultural development. With the support of the digital ecological theory, agricultural enterprises will be introduced into the digital SCF platform to promote the digital transformation of agricultural industry, integrate the agricultural industry chain, strengthen the connection between the participants of the agricultural industry chain, give play to industrial synergy, and enhance the overall competitiveness of the agricultural industry. The development of ASCF can further enhance the development strength of vulnerable enterprises in the ASC, break the "starry sky pattern" and "Matthew effect" in industrial upgrading, and promote the realization of SPR.

Strong effect: Financial transformation promoting SPR in agriculture

Financial institutions' mastery of the information of supply chain participants determines the effect of financing and the size of financing risks. Most of the traditional offline SCF guarantees are based on the inventory and claims of supply chain enterprises. Financial institutions cannot accurately judge the quantity, quality and value dynamics of assets, increasing financing risks. With the application of big data, Internet of things, blockchain, artificial intelligence and other technologies, the data in the ASC is fully circulated, and the credit is evaluated based on the data to reduce the operational risk of financial institutions. For example, strengthen the combination of traditional agricultural industry and financial technology, achieve in-depth scenario data risk control, and strive to create a new financial model of "scenario + technology + finance" [21]. At the same time, in the GASCF platform established based on the double carbon policy, financial institutions can give priority to financing low-carbon enterprises and increase the loan interest of polluting enterprises, so as to force agricultural enterprises to move towards the path of scientific and technological emission reduction and promote the SPR of ASCF.

INNOVATION OF GASCF MODEL UNDER THE BACKGROUND OF DIGITAL TECHNOLOGY

Core elements of GASCF model

GASCF platform

The digital platform is the hub of the ASCF ecosystem, which integrates Internet, big data, artificial intelligence and other technologies to provide agricultural enterprises with various public services, including finance. With the help of big data and Internet technology, heterogeneous organizations such as agricultural enterprises, financial institutions and other production-oriented service subjects operate in the ASCF ecosystem platform. On the premise of maintaining the ownership of the subject property rights, they realize cross industry business reengineering through data fusion based on the ecological contract, form an organic whole of different subjects with high efficiency and low cost, and realize the multi-agent joint operation of the ecological platform, Innovate the new ecological mode of digital restructuring industry. It is with the digital platform of GASCF that the financial ecosystem of the whole ASC shows integrity and the data has the possibility of convergence and integration.

Agricultural enterprises

Agricultural enterprises refer to the upstream and downstream enterprises that participate in transactions on the ASCF platform, and are also the main objects of the ASCF platform. With the support of the digital platform, agricultural enterprises form a

number of horizontal cluster chains and vertical industrial chains, which are organically coupled with the service chain in the platform, coordinate and cooperate with each other, form a complex ASCF network, expand the service objects and information source channels of the ASCF platform, and provide massive data and more markets for the development of ASCF.

Productive service institutions

Producer services refers to the institutions that provide public services such as capital, logistics and communication on the ASCF platform. Among them, financial institutions are capital providers in digital platforms, including commercial banks, P2P, trust companies and small loan companies; With the help of digital platform, logistics enterprises reduce transportation costs, improve logistics timeliness, timely provide warehousing, transportation, storage and other services for agricultural enterprises that adopt mortgage financing, timely and dynamically update the value of collateral, and provide credit basis for financial institutions to agricultural enterprises; Communication companies and trading centers provide strong technical support and various transaction guarantees for the operation of digital platforms. The participation of these producer services institutions can help improve the overall competitiveness of the ASC.

Construction of GASCF platform

The GASCF platform plays the role of information intermediary service platform, mainly serving the ASC, and providing an equal and open trading platform for investors and farmers' borrowers. The GASCF platform includes three core ports: risk control, credit enhancement and capital settlement. The core port reveals how farmers and small and micro enterprises can solve the problems of credit investigation and financing in the ASCF platform under the guidance of advantages. As shown in Figure 2, the GASCF platform relies on information processing and technology empowerment, fully considers various potential risks that may exist, and puts forward measures to solve the problem of risk control. Secondly, at the credit enhancement port, the risks of agricultural financing institutions are further dispersed through risk guarantee measures such as structured credit, guarantee and social credit investigation. Finally, at the capital settlement port, reduce the fund contact of the platform and further reduce the financing risk.

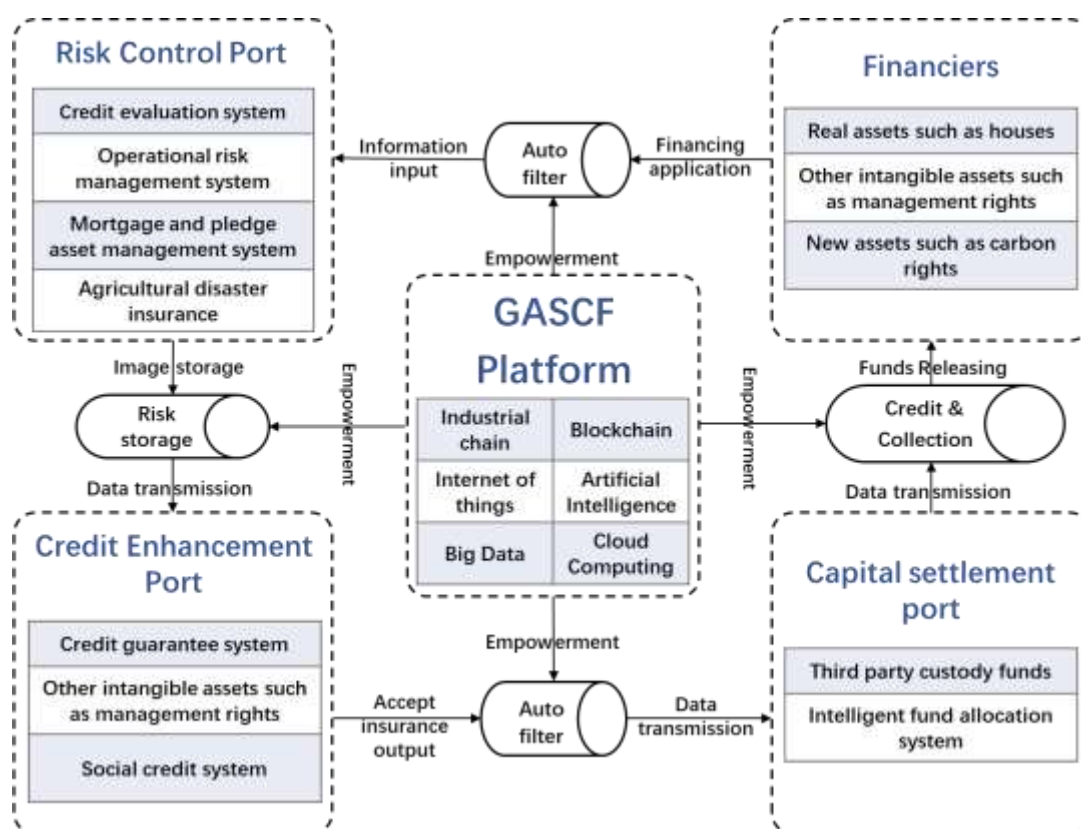


Figure 2: Construction of GASCF platform

Design of core modules and key control points

The core module of the GASCF model mainly includes three ports: risk control, credit enhancement and capital settlement. Each core port should have the functions of receiving information, enabling technology, filtering output, etc. This section will analyze the operation design of the three core ports of the GASCF model from the construction of core modules and key control points.

Risk control port

Risk control needs to make full use of technology agglomeration and system agglomeration, improve the risk prevention and control system, and consolidate the foundation of financial services. Financial institutions should do a good job in risk

prevention and control, and provide sustainable financial services for high-quality agricultural industry operators. First of all, we should establish a reasonable credit evaluation system, actively develop the credit rating system of the industrial chain, and establish an objective and scientific evaluation system of the credit level of the participants in the agricultural industrial chain on the basis of evaluating the market potential and trade authenticity of the whole industrial chain. Secondly, strengthen the internal control of business operational risk, improve the operational risk management system, and realize the effective control of the operational risk of each process. At the same time, it is also necessary to improve the dynamic management of mortgage and pledge assets, establish a real-time tracking system for the price of mortgage and pledge, and set a warning line for price fluctuations, so as to timely add margin or supplement mortgage and pledge assets, and effectively control the risk of changes in the value of mortgage and pledge assets. In addition, in order to better transfer and disperse agricultural natural disasters, epidemics and other self owned risks, stabilize the agricultural economy, and increase investment in agricultural insurance is particularly necessary. According to the guidance of national policies, we need to strengthen the protection of policy insurance, increase the types of commercial insurance, improve the agricultural disaster risk transfer system, establish catastrophe insurance project funds, establish small-scale agricultural insurance, and support enterprises engaged in agricultural insurance through subsidies and reinsurance, so as to lay a good foundation for the development of GASCF.

Credit enhancement port

Credit enhancement ports include credit guarantee system, social credit investigation system and agricultural chain structured credit. The three cooperate with each other to jointly improve the credit rating of financing parties. Firstly, introduce a credit guarantee system. Through data analysis and resource retrieval, the Internet financial platform matches suitable guarantee companies for farmers and small and micro enterprises, and promotes the two-way choice between financing demanders and guarantors, so as to achieve an enhanced effect. The ASCF platform has moved the guarantee from offline to online, which not only expands the business scope of the guarantee company, but also makes the guarantee information more transparent. Farmers and small and micro enterprises can obtain the guarantee more quickly and conveniently, and improve the loan experience. The data shows that the ASC composed of small-scale farmers with limited funds and intermediary platforms, under the guarantee and direct financing, the production level of farmers can even be higher than the centralized decision-making. Therefore, China should give play to the advantages of agglomeration, refer to the advantages of foreign farmers' loan guarantee mechanism, and combine with its national conditions, increase government guarantee support, and appropriately adjust the supply chain guarantee requirements. Secured loans can effectively fill the credit gap, solve the financing difficulties of farmers and small and micro enterprises, and vigorously promote the development of ASCF. Secondly, it should be incorporated into the social credit reporting system. It can also play the role of credit enhancement. Through the big data, cloud computing and artificial intelligence technologies in the application platform, we can deeply mine and analyze the information from industry and commerce, taxation and other public services, and depict the credit status of financing subjects through user portraits [23], providing a reliable basis for financial decision-making in the ASC. Thirdly, the use of agricultural chain structured credit. As a financing provider, the core enterprise of the ASC is undoubtedly a high-quality borrowing enterprise, which can give full play to the agglomeration of capital advantages. Agricultural core enterprises have a better understanding of farmers' financing information and needs in their ASC. They can determine farmers' credit rating through transaction records and social credit investigation, so as to reduce financing costs and financing risks. This in itself is to enhance the credit of farmers. In addition, in the accounts receivable business, accounts receivable and industrial chain trade are guaranteed. The core enterprises providing financing are internal enterprises in the ASC, and the corresponding trade loans can also be frozen.

Capital settlement port

The GASCF platform introduces substantial linkage advantages of third-party custody companies. When investors recharge and invest, the funds will be directly remitted to the independent third-party custody account of the platform. When the standard is full, the platform cannot touch this loan, which fundamentally eliminates the online loan fund pool and reduces the liquidity risk of funds to the greatest extent. Secondly, the platform has established efficient and convenient financial clearing and payment services for the smooth implementation of ASCF and the financial transaction needs of farmers' production and life. For example, the Internet financial platform gives full play to its innovative advantages, absorbs the advanced achievements of other excellent supply chain platforms, opens the real name authentication of platform users, accounts collection system and allows the application of electronic signatures for signing. The GASCF platform makes the agricultural market system more standardized, farmers' awareness of reputation and environmental protection enhanced, and promotes the long-term development of agriculture. At the same time, the huge development space behind the GASCF can stimulate market innovation, gradually screen out the disadvantages of the traditional agricultural chain, abandon heavy industry, non-low-carbon projects, and turn to green finance. In addition, the systematic and scientific financing system of the GASCF model can make the ASCF develop better and more stably, actively guide the green transformation of the agricultural industry chain, and radiate the development of other industries while driving the development of agricultural economy. Therefore, the digital platform built by the GASCF model can give full play to the guiding role of agglomeration advantages, cooperate with the government guidance, and further promote the SPR work.

THE REALISTIC DILEMMA OF GASCF IN HELPING SPR

Lack of comprehensive management ability of the organization

GASCF ecosystem presents the structural characteristics of loose coupling. The system will not lose its core because its functions are scattered among different industrial subjects and service subjects, and each subject will not lose its original characteristics due to integration into the system. However, due to the lack of stickiness of different subjects in the loose

coupling structure and great differences in value orientation, it is difficult to find a high-level leader with strong influence to fully intervene (Li *et al.*, 2015). At present, the ASCF model led by different leaders has significant differences in solving the capital investment of agricultural enterprises, the demand for credit enhancement and risk control. Supply chain managers lack knowledge and information about SCF projects (Hofmann & Belin, 2011), which will restrict and restrict the introduction of agricultural low-carbon environmental protection projects, and cause the mismatch between finance and "high energy consumption, high emission" projects. The lack of coordination between different departments within the organization will not only weaken the platform's ability to control the depth of the ASC scenario and the comprehensive risk, but also increase the difficulty of building a collaborative network based on multi-agent professional division of labor (Fawcett *et al.* 2008). More importantly, it is difficult to form an intensive organization to achieve the continuous agglomeration and innovative development of the platform's advantageous resources and capabilities, affecting the benefits of the entire ASC system. In addition, the lack of comprehensive management ability of the organization is also reflected in the insufficient maintenance and development ability of the GASCF operation platform, the lack of the characteristics and potential of developing the ecological operation platform, and the inability to provide complete business guidance, production management, financial support and other services for agricultural enterprises, which affects the SPR effect of ASCF.

Insufficient application of digital technology

An important condition for the innovative construction of GASCF model is the application support of emerging technologies such as Internet, big data and artificial intelligence. However, due to the weak agricultural and rural infrastructure, the application of digital technology to build SCF platform is facing many challenges. Although ASCF has developed from the traditional manual process based on paper media to online, due to the lack of scientific and technological talents who understand finance and ASC management, the application of new generation technologies such as blockchain and Internet of things has not been popularized, especially the integration and application of multiple technologies is difficult to achieve, and it is difficult to comprehensively apply all kinds of emerging technologies to all modules of ASCF digital platform under current conditions. At the same time, the application cost of emerging technologies is high, especially the high labor cost and infrastructure construction cost. The organization cannot afford the technical cost required by the financing platform, so the comprehensive application of information technology in ASCF is not sufficient. In addition, China's SCF information platforms generally lack basic standards, resulting in inconsistent information system interfaces between the platform and various participants, the formulation of relevant technical standards is difficult to meet the needs of the operation of ASCF mode, and the participants are unable to achieve the entry of batch business data. At the same time, a large number of personalized interfaces reduce the operation efficiency of the platform, resulting in the upward operation cost of the platform. The insufficient application of digital technology limits the breadth, depth and accuracy of the digital transformation of GASCF, and restricts the service efficiency, quality and effect of GASCF in helping SPR.

Imperfect institutional environment

In recent years, the Chinese government has successively issued corresponding financial support policies around the development of "agriculture, rural areas and farmers", which provides a top-level design and institutional basis for promoting the standardized operation and innovative development of ASCF. However, from the regulatory perspective, although there are many regulatory systems related to agricultural finance and SCF, these regulatory policies, ideas and rules are mainly aimed at the ASCF business carried out by commercial banks, and do not fully consider the relatively complex risk-taking and professional division of labor led by other organizations. Therefore, the ASCF model dominated by agricultural core enterprises or fintech platforms is difficult to be incorporated into the current prudential regulatory framework with institutions as the main body. At the same time, due to the influence of China's "separate operation and separate control" system, it is difficult to issue unified supervision rules across industries in the short term. From a legal perspective, there is a gap in China's laws and regulations related to ASCF, which leads to the lack of proper order, norms and legal protection in the financial market, and increases the financing difficulty of agricultural enterprises. At the same time, the particularity of enterprises in the ASC, scattered origin, long transportation time and distance, non-standard or even lack of financial information, makes the relevant departments lack effective supervision and supervision over small-scale agricultural enterprises and farmers. In addition, the diversification of financial entities and services in the ASC puts forward higher requirements for the coverage of laws and regulations, especially with the application of digital technology, the current laws and regulations such as the insurance law, the securities law, the guarantee law and the electronic signature law have not set legal standards for the digital business qualification, algorithm mechanism and information security components of the operation platform institutions, The legal environment lagging behind the business development increases the operational risk of the ASCF model. The imperfection of the legal and regulatory system has led to the operational risk of ASCF, which is not conducive to the realization of sustainable poverty reduction in ASCF. At the same time, the lack of relevant guiding policies such as green supply chain and green integration of industry and finance also restricts the innovative development of green SCF.

Lack of compound talents

Talent support is one of the key factors for ASCF to achieve sustainable poverty reduction. In recent years, the number of SCF business companies has shown a blowout growth. At the same time, the application of digital technology in SCF has led to a large shortage of related compound human resources. The market urgently needs compound talents who master ASC management, understand finance and master digital technology. According to the statistics of the Research Report on the employment impact of the digital economy issued by the China Academy of information and communications, with the digital transformation of the whole society and the whole industry, the gap of digital talents in China is very large, and the imbalance

in the distribution of digital talents in agriculture and remote areas also has a negative impact on the sustainable development of China's digital agricultural economy. Facing the strengthening of digital trend, the innovative development of GASCF depends on the green concept, innovative thinking and innovative ability of financial science and technology talents. At present, from the government, society to colleges and universities, there is a lack of comprehensive talent training system for ASCF. The government has not put forward a strategic plan for the training of SCF technology talents from the top-level design, the training of SCF composite talents by social training institutions is not systematic, the training of SCF talents by colleges and universities seriously lags behind the market demand, many new technologies seriously lag behind the practical needs in theory, and the level of teachers cannot keep up. The serious lack of compound talents is an important bottleneck restricting the digital transformation of ASCF, which objectively hinders the efficiency and effect of sustainable poverty reduction in ASCF.

THE PATH OF GASCF TO HELP SPR

In view of the practical difficulties of GASCF in supporting sustainable poverty reduction, such as the lack of comprehensive management ability of the organization, the insufficient application of digital technology, the imperfect institutional environment and the lack of compound talents, we should formulate a four in one path of ASCF for sustainable poverty reduction, which is "government standardized guidance, financial institutions' assistance, industrial main body drive and Social Service Co governance".

Government standardizing and leading

Government departments should play a macro guiding role in the sustainable poverty reduction of GASCF. First of all, the government needs to formulate a new regulatory system to adapt to the complex risk-taking and professional division of labor under the ASCF model dominated by agricultural core enterprises or fintech platforms, such as data regulation of ASCF platforms, potential risk regulation of supporting producer services, etc. Secondly, the government needs to formulate and implement the development strategy for the construction of ASCF talents from the top, formulate the training plan for leading talents in ASCF, build a perfect "supply chain management + Finance + technology" talent training system, and rely on universities and scientific research institutions to increase the training of professional and compound talents. At the same time, it is necessary to carry out or participate in international academic exchanges with an open attitude, actively learn from the advanced concepts of foreign ASCF development and the innovative experience of science and technology, and introduce high-level ASCF talents to the world. Thirdly, the legislative department needs to improve relevant laws and regulations to build a good legal environment for the development of ASCF. For example, the property law stipulates that only the items listed in the law can be used as collateral, while the types of collateral for small agricultural enterprises and farmers are complex, and agricultural products have non standardized attributes. Therefore, there are a large number of collateral not listed in the property law in ASCF. Therefore, based on the advanced chattel financing guarantee system in foreign countries, the scope of collateral can be expanded to further improve the types of collateral⁸. Finally, the government needs to create a policy atmosphere for the integrated development of green agriculture and green finance, establish and improve the agricultural green low-carbon investment and financing system, and promote agricultural low-carbon development.

Assistance from financial institutions

Financial institutions are the capital guarantee for the benign operation of the GASCF platform. However, there are still some problems in financial institutions, such as the insufficient application of digital technology, the lack of financial talents in agriculture related fields, especially the insufficient support for agricultural green finance. Therefore, in order to help achieve sustainable poverty reduction in ASCF, financial institutions need to adapt to the transformation of digital finance as soon as possible, introduce digital credit evaluation and risk control systems in the financing process, and realize the integration and application of various digital technologies in the financial field as soon as possible. At the same time, we should speed up the training and absorption of compound talents who are proficient in ASC management, finance and digital technology, give play to the important value of financial institutions themselves in the continuous training of talents, closely grasp the changes of relevant policies and regulations in the field of ASCF, and timely adjust the operation and management of financial institutions, so that they can better contribute to the sustainable poverty reduction development of ASCF. In addition, financial institutions should conscientiously implement the "double carbon" goal, adhere to green development to lead business operations, constantly improve the quality, efficiency and coverage of green financial services, vigorously develop green financial products, continue to accelerate the innovation of green financial products and services, and comprehensively help the green low-carbon transformation and high-quality development of the agricultural economy.

Driven by industrial subjects

Agricultural enterprises are the new force to promote GASCF to help sustainable poverty reduction, and play an important driving role in the development of sustainable poverty reduction in ASC. First of all, agricultural enterprises need to implement the concept of green development, fully understand the importance of ecological priority and green development, shift agricultural production from blindly pursuing output to paying equal attention to quantity and quality, cultivate green technology promotion talents, attract high-end talents, improve the scientific and technological level of the agricultural industry, introduce advanced agricultural mechanized farming technology, and improve the level of green production technology, Create conditions for promoting ASCF to help sustainable poverty reduction. Secondly, agricultural enterprises should take advantage of the policy dividends of the new agricultural infrastructure and use digital technology to improve agricultural production efficiency. Through the construction of infrastructure in the ASC, the digitization of ASC links, the digitization of production links, the digitization of orders, the digitization of supply and demand relations and other links, the

entire industrial link of agricultural products from the field to the table will be opened up, and the agricultural industry will be empowered by the technological advantages precipitated by big data, Promote the upgrading of the agricultural industrial chain. Therefore, with the empowerment of digital technology, green ASCF will be smoother. In the service of "agriculture, rural areas and farmers", precision poverty alleviation and other scenarios, we will continue to develop innovative financial services and products to provide financial services for long tail customers that are difficult to reach by traditional inclusive finance, so as to expand the availability, coverage and satisfaction of GASCF services.

Co governance of Social Service

Under the guarantee of social productive service institutions, the practical problems that restrict the sustainable poverty reduction development of ASCF, such as the lack of timeliness of agricultural logistics, the imperfect credit and risk control system, and the lack of agricultural compound talents, can be solved. First of all, logistics enterprises in the ASCF system, relying on the digital financing platform, establish a digital logistics system to ensure the timeliness of logistics in the ASC. At the same time, strengthen the infrastructure construction of the logistics industry, increase the investment in logistics hardware facilities, and then reduce logistics costs. Secondly, the participation of third-party evaluation institutions, environmental testing institutions and other service institutions has made the credit and asset evaluation of ASCF more professional, and accelerated the transformation of agricultural projects with "high energy consumption and high emissions". Finally, to explore the cooperative training mode of "industry university research" in GASCF, social training institutions need to strengthen the exchange and cooperation with enterprises and universities, so as to realize the effective docking between enterprises and universities and scientific research institutions. At the same time, the society cooperates with many parties to build a GASCF industry university research cooperation base, increase the opportunities for scientific and technological talents to practice, and improve the application and transformation ability of scientific research achievements in the practice of agricultural enterprises.

CONCLUSION

We explore the internal mechanism and dynamic mechanism of ASCF helping to reduce sustainable poverty in this paper, and based on the background of digital technology, innovate the ASCF model, analyze the practical difficulties restricting ASCF helping to reduce sustainable poverty, and then seek countermeasures and suggestions for ASCF helping to reduce sustainable poverty. First of all, from the perspective of financial services, management services and coordination services, this paper analyzes the internal mechanism of sustainable poverty reduction of ASCF, studies and puts forward innovative financial service functions of ASCF, and promotes the stable development of ASC; Give full play to the management role of ASCF and promote the low-carbon transformation of ASC; Optimize the coordination function of ASCF and improve the comprehensive income of ASC. Secondly, following the internal logic of "motivation behavior", this paper explores the internal and external driving forces of sustainable poverty reduction in ASCF, including industrial upgrading and financial transformation; External driving forces include technological change, policy guidance and market drive. Third, based on the background of digital technology, innovate the GASCF model, analyze the core elements and platform structure, and focus on the process design and key points of the three modules of the platform: risk control end, credit end and capital end. Finally, in view of the practical difficulties of the lack of comprehensive management ability of the organization, the insufficient application of digital technology, the imperfect institutional environment and the lack of compound talents of GASCF in helping sustainable poverty reduction, this paper puts forward a four in one construction path of GASCF helping sustainable poverty reduction, which is "government normative guidance, financial institution assistance, industry main body drive and Social Service Co governance".

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Research on promotion mode of dual channel supply chain considering consumer channel preference

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ABSTRACT

This paper concentrates on the dual-channel supply chain considering consumer channel preference, which manufacturers through online direct sales and retailers through offline retail, and constructs different promotion models: manufacturers and retailers do not promote, the retailer does promotion and the manufacturer does promotion, while considering consumers' channel preferences, study the impact of promotion on the profit and performance of supply chain system members, and finally get the best promotion strategy for retailers and manufacturers through comparative analysis. It is of extraordinary viable importance to make reasonable promotion decisions for members of the dual-channel supply chain system.

Keywords: Dual channels, supply chain, promotion effort, channel preference.

1. INTRODUCTION

With the development of the Internet, product information has become more open and transparent, and the homogeneity of products sold by companies has become more and more serious. "Promotion" has become an important means for supply chain companies to improve their own performance. "Promotion" refers to a way for companies to use various activities and methods to attract consumers to pay attention to their products, stimulate consumers' desire to buy, and promote product sales. This article refers to the act of "promotion" by members of the supply chain as "promotional effort". Offline retailers carry out promotions through shop display board advertisements, leaflet printing, and human sales promotion; online merchants rely on the advantages of a large number of Internet users to promote sales through paid personalized push, full reduction activities and other promotional methods. As the advantages of the Internet have become increasingly prominent, manufacturers have gradually opened up their own online direct sales channels, forming a dual-channel supply chain where both online and offline coexist. According to the different promoters of the promotion, this article divides it into three different models, namely, the manufacturer and the retailer do not make promotion efforts, the retailer side makes the promotion effort, and the manufacturer side makes the promotion effort.

So what impact do these three promotion efforts models have on the profits and performance of the members of the dual-channel supply chain system? Huang and Bai believe that the promotional reference effect will lessen the benefits of retailers and increase the profits of manufacturers (Huang et. al, 2018). Li and Yang believe that retailers always charge higher prices when they carry out coupon promotions (Li et. al, 2021). Jin establish a supply chain model with limited capital and demand dependent on retail price and promotion efforts, and find that the chain operation mode is beneficial to all supply chain members (Jin et.al, 2015). Heidarpour and Heydari believe that the buy-one-get-one incentive scheme will make the supply chain more profitable under the coordination contract (Heydari et.al, 2020). Bai and Chen believe that in the supply chain where demand is affected by promotional efforts, the cooperation between manufacturers and retailers can generate higher profits (Bai et.al, 2017). Tsay and Agrawa considers the impact of channel inclination and sales effort on demand, the dual channel pricing strategy (Tsay & Agrawal, 2009).

From the current research literature, it can be found that there are few studies that combine consumer channel preferences and dual-channel supply chain promotion models at the same time. In order to be close to the reality, this article also takes into account the consumer's channel preferences, establishes a manufacturer-led Stackelberg game model, compares and analyzes the optimal decision and profit of the manufacturer and the retailer, and obtains the optimal promotion for the manufacturer and the retailer. Strategies have important reference value and practical significance for the development of promotion strategies for dual-channel supply chain companies.

2. PROBLEM DESCRIPTION AND MODEL BUILDING

2.1. Problem Description

This article studies a dual-channel supply chain composed of manufacturers' online direct deals channels and retailers' disconnected retail channels, in which manufacturers wholesale products to retailers at a unit price w , and retailers sell to consumers at a unit price P_r . Manufacturers of online direct sales channels sell products to consumers at a unit price P_m . According to the different promoters of the promotion, it can be divided into the following modes, as shown in Figure 1..

Mode N: Manufacturers and retailers do not make promotions

Mode R: The retailer does a promotion
 Mode M: The producer does a promotion

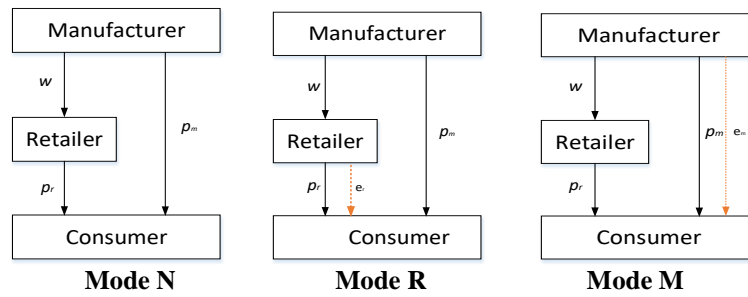


Figure 1. Diagram of the promotion effort model of the dual-channel supply chain system

2.2. Model building

According to the above three modes, the profit function of the system members is established, and then the respective optimal decisions are solved, and the profit situation under the various modes is compared and analyzed, and the optimal promotion strategy is obtained. In the following text, the superscripts N, R, and M are used to denote the N mode, R mode and M mode, respectively, and the superscript * denotes the optimal decision. The subscripts r and m denote the retailer and the manufacturer, respectively, and π_r and π_m denote the retailer, respectively. And the profit of the manufacturer, the total profit of the supply chain system is expressed as π , and $\pi = \pi_r + \pi_m$.

The basic hypothesis of this article : ① The production cost of the manufacturer will not have a substantial impact on the research results of this article. It is assumed that the creation cost of the maker is zero. ② Manufacturers and retailers are completely rational and risk-neutral, and both take the maximization of their own interests as their decision-making goals. ③ The level of promotion effort can be accurately quantified. ④ Referring to the product demand function constructed by Huo Hong [3] and Liu Xinmin [7], market demand is affected by the online direct selling price p_m , offline retail price p_r , the influence coefficient β ($\beta > 0$) of promotion effort on demand, and promotion The impact of effort level e_i ($e_i > 0$), where $i=r, m$ represent the retailer and the manufacturer, respectively. Suppose the offline market demand function is $q_r = na - p_r + bp_m + \beta e_r$, and the online market demand function is $q_m = (1 - n)a - p_m + bp_r + \beta e_m$. Among them, a represents the potential market demand, n represents the consumer's preference for consumption in traditional retail channels ($0 < n < 1$), and b represents the consumer's price sensitivity coefficient ($0 < b < 1$), which can reflect consumers' competitive price The degree of sensitivity. ⑤ Similar to the research of Huo Hong [10], the promotion effort cost is set as $C(e_i) = 1/2 \mu e_i^2$, where μ ($\mu > 0$) describes the cost coefficient of promotion effort. ⑥ The manufacturer is the head of the supply chain, and the retailer is the adherent.. Both of them obey the Stackelberg game in their decision-making..

3. MODEL OPTIMAL DECISION

3.1. Model N: Manufacturers and retailers do not make promotions

This section studies the N mode as a benchmark for comparison of several other modes. When neither the manufacturer nor the retailer makes promotional efforts, $e_r = 0$ and $e_m = 0$ at this time. The demand functions of retailers and manufacturers are as follows:

$$q_r = na - p_r + bp_m, q_m = (1 - n)a - p_m + bp_r$$

The profit functions of retailers and manufacturers as per the following:

$$\pi_r = (p_r - w)q_r, \pi_m = p_m q_m + wq_r$$

Next, as indicated by the profit function of the manufacturer and the retailer in the N model, the manufacturer's optimal wholesale price and the optimal online direct selling price can be obtained; the retailer's optimal retail price; the manufacturer and the retailer's respective maximum profit .

Theorem 1: In model N, the optimal decision and profit of the supply chain are as follows:

$$w^{N*} = \frac{a(n+b-nb)}{2(1-b^2)}, p_m^{N*} = \frac{a(1-n+nb)}{2(1-b^2)}, p_r^{N*} = \frac{a(2b+3n-2nb-nb^2)}{4(1-b^2)}$$

$$\pi_m^{N*} = \frac{a^2(n^2b^2-4n^2b+4nb+3n^2-4n+2)}{8(1-b^2)}, \pi_r^{N*} = \frac{n^2a^2}{16}$$

Proof: It can be obtained by using reverse derivation method, See appendix for proof.

3.2. Mode R: Only retailers make promotion decisions

When only the retailer makes promotion efforts, $e_r > 0$ and $e_m = 0$ at this time. The demand functions of retailers and manufacturers are as follows:

$$q_r = na - p_r + bp_m + \beta e_r, \quad q_m = (1 - n)a - p_m + bp_r$$

The profit functions of retailers and manufacturers are as follows:

$$\pi_r = (p_r - w)q_r - \frac{1}{2}\mu e_r^2, \quad \pi_m = p_m q_m + wq_r$$

Next, as indicated by the profit function of the manufacturer and the retailer in the R model, the manufacturer's optimal wholesale price and the optimal online direct selling price can be obtained; the retailer's optimal retail price; the manufacturer and the retailer's respective maximum profit And the total profit of the dual-channel supply chain system

Theorem 2: In model R, the optimal decision and profit of the supply chain are as follows

:

$$\begin{aligned} w^{R*} &= \frac{a(4\mu^2(b+n-bn)-4b\mu\beta^2(1-n)-n\mu\beta^2(2+b^2)+b\beta^2(1-n\beta^2))}{4\mu(1-b^2)(2\mu-\beta^2)-\beta^4b^2}, & p_m^{R*} &= \frac{a\mu(2(1-n)(2\mu-\beta^2)+bn(4\mu-\beta^2))}{4\mu(1-b^2)(2\mu-\beta^2)-\beta^4b^2} \\ p_r^{R*} &= \frac{a((1-n)(4b\mu^2-3\beta^2b\mu+\beta^4b)+2n\mu(\mu(3-b^2)-\beta^2))}{4\mu(1-b^2)(2\mu-\beta^2)-\beta^4b^2}, & e_r^{R*} &= \frac{a\beta(2n\mu(1-b^2)+b\beta^2(1-n+bn))}{4\mu(1-b^2)(2\mu-\beta^2)-\beta^4b^2} \\ \pi_m^{R*} &= \frac{a^2\mu(\beta^2(n(bn-b-n+2)-1)-4\mu n(bn+1-b)+\mu(b^2n^2+3n^2+2))}{4\mu(1-b^2)(2\mu-\beta^2)-\beta^4b^2}, & \pi_r^{R*} &= \frac{a^2\mu(2\mu-\beta^2)(2n\mu(1-b^2)+b\beta^2(1+bn-n))^2}{2(4\mu(1-b^2)(2\mu-\beta^2)-\beta^4b^2)^2} \end{aligned}$$

Proof: It can be obtained by using reverse derivation method, See appendix for proof.

3.3. Mode M: Only the manufacturer makes promotion decisions

Only when the manufacturer makes promotional efforts, $e_r=0$ and $e_m>0$ at this time. The demand functions of retailers and manufacturers are as follows:

$$q_r = na - p_r + bp_m, \quad q_m = (1 - n)a - p_m + bp_r + \beta e_m$$

The profit functions of retailers and manufacturers are as follows:

$$\pi_r = (p_r - w)q_r, \quad \pi_m = p_m q_m + wq_r - \frac{1}{2}\mu e_m^2$$

Next, according to the profit function of the manufacturer and the retailer in the model M, the manufacturer's optimal wholesale price and the optimal online direct selling price can be obtained; the retailer's optimal retail price; the manufacturer and the retailer's respective maximum profit.

Theorem 3: In model M, the optimal decision and profit of the supply chain are as follows:

$$\begin{aligned} w^{M*} &= \frac{a(2\mu(b+n-bn)-n\beta^2)}{2(2\mu-\beta^2-2\mu b^2)}, & p_m^{M*} &= \frac{a\mu(1+bn-n)}{2\mu-\beta^2-2\mu b^2}, & e_m^{R*} &= \frac{a\beta(1+bn-n)}{2\mu-\beta^2-2\mu b^2}, & p_r^{M*} &= \frac{a(2b\mu(2-bn-2n)+3n(2\mu-\beta^2))}{4(2\mu-\beta^2-2\mu b^2)}, \\ \pi_m^{M*} &= \frac{a^2(8\mu n(b-1-bn)+n^2(6\mu+2\mu b^2-\beta^2)+4\mu)}{8(2\mu-\beta^2-2\mu b^2)}, & \pi_r^{M*} &= \frac{a^2n^2}{16} \end{aligned}$$

Proof: It can be obtained by using reverse derivation method, See appendix for proof.

4. MODEL COMPARISON ANALYSIS

4.1. Comparative Analysis of Optimal Decisions

Proposition 1: In model N, model R, and model M, the traditional retail channel demand q_r and retailer's promotion effort level e_r are increasing functions of n , and the direct sales channel demand q_m and the manufacturer's promotion effort level e_m are decreasing functions of n .

Proof: It is easy to obtain the derivative of each of the above quantities with respect to n , which is omitted here.

Proposition 2:(1) When the retailer makes promotional efforts, the demand for offline retail channels increases, that is, $q_r^{R*} > q_r^{M*} = q_r^{N*}$.(2) When the manufacturer makes sales promotion efforts, the demand for online direct sales channels increases, and the demand for offline retail channels decreases, that is, $q_m^{M*} > q_m^{N*} > q_m^{R*}$.

Proof: It can be obtained by making the difference of the demand in the proposition compared with each other, which is omitted here.

Proposition 3: The manufacturer's online direct selling price p_m is a decreasing function of n , while the manufacturer's wholesale price w and the retailer's retail price p_r are an increasing function of n .

Proof: It can be obtained by deriving the derivation of each quantity in the proposition with respect to n , which is omitted here.

Proposition 4: When the retailer makes a promotional effort, the manufacturer's wholesale price will decrease, that is, $w^{R^*} < w^{N^*}$; when the manufacturer makes a promotional effort, the manufacturer's wholesale price will be increase, that is, $w^{M^*} > w^{N^*}$.

Proof: The wholesale price of the manufacturers compared with each other in the proposition can be obtained by making a difference, which is omitted here.

Proposition 4 shows that when a retailer makes a promotion effort, the retailer will pay the cost of the promotion effort. In order to alleviate the "double marginal effect", the manufacturer will lower the wholesale price. When a manufacturer makes a promotion effort, the manufacturer will pay the cost of the promotion effort. In order to maintain its own income and improve its competitive advantage, the manufacturer increases the wholesale price to the retailer.

Proposition 5: When a manufacturer or retailer makes a promotional effort:

On the one hand, offline retail prices of retailers will rise, that is, $p_r^{R^*} > p_r^{N^*}$, $p_r^{M^*} > p_r^{N^*}$;

On the other hand, the direct selling prices of manufacturers will also increase, that is, $p_m^{R^*} > p_m^{N^*}$, $p_m^{M^*} > p_m^{N^*}$.

Proof: The difference between the retailer's retail price and the manufacturer's online direct selling price in the proposition can be obtained, which is omitted here.

Proposition 5 shows that when retailers make promotional efforts, consumer demand in traditional retail channels increases. In order to obtain more profits, retailers raise retail prices at this time, but they use promotional methods to feed back some benefits. Because the products of manufacturers and retailers are competitive between channels, to increment online profits, manufacturers also appropriately increase online direct selling prices. When the manufacturer makes a sales promotion effort, the demand for online direct sales channels increases, and the manufacturer increases the direct sales price in order to obtain more profits.

4.2. Maximum profit comparative analysis

Theorem 4: As long as the retailer makes promotional efforts, the retailer's profit will increase, and the retailer will profit from it, that is, $\Pi_r^{R^*} > \Pi_r^{M^*} = \Pi_r^{N^*}$.

Proof: The profit of each retailer compared with each other in the proposition can be obtained by making a difference, which is omitted here.

Theorem 4 shows that when a retailer makes a marketing effort alone, the retailer's profit will increase. This is mainly due to the fact that after retailers have made promotional efforts, the increase in profits brought about by increased retail channel demand, lower wholesale prices and rising retail prices is greater than the reduction in costs of promotional efforts.

Theorem 5: (1) As long as the manufacturer or retailer makes promotion efforts, the profit of the manufacturer will increase, that is, $\Pi_m^{R^*} > \Pi_m^{N^*}$, $\Pi_m^{M^*} > \Pi_m^{N^*}$.

(2) When $n < h$, $\Pi_m^{M^*} > \Pi_m^{R^*}$; When $n > h$, $\Pi_m^{M^*} < \Pi_m^{R^*}$;

$$\text{among them : } h = \frac{-(8\beta^2\mu + 8b\mu^2 + 2(\mu(2+b^2)(\beta^2 + 2\mu b^2 - 2\mu)(\beta^4 b^2 - 4\beta^2 b^2 + 4\beta^2\mu + 8b^2\mu^2 - 8\mu^2))^{\frac{1}{2}}}{(\beta^4 b^2 - 16b\mu^2 - \beta^2(2\mu b^4 - 8\mu b^3 + 10\mu b^2 - 8\mu b + 4\mu) + 8\mu^2 + 16b^2\mu^2 - 16b^3\mu^2 + 8b^4\mu^2)}$$

Proof: It can be obtained by comparing the profits of each manufacturer in the proposition with each other, which is omitted here.

Theorem 5 shows that whether it is a sales promotion effort by a manufacturer or a retailer, the profit of the manufacturer will increase. When the manufacturer makes promotional efforts, the original consumer demand of the retail channel will not change. The increase in the profit of the manufacturer is due to the increase in the wholesale price of the retail channel on the one hand; on the other hand, the increase in demand for the online direct sales channel and The increase in profits brought about by the increase in direct selling prices is greater than the decrease in the cost of promotion. When the retailer makes a promotional effort, the demand for online direct sales channels will not be affected. The increase in the profit of the manufacturer is due to the increase in retail channel demand, which is greater than the decrease in wholesale price. If only one side of the manufacturer or retailer is considered for promotion efforts, when consumers have less consumer preference for traditional channels ($n < h$), the profit of the manufacturer's independent promotion efforts is greater, which is more beneficial to the manufacturer. When consumers have greater preference for traditional consumption ($n > h$), and retailers make promotional efforts alone, the manufacturer's profits will be greater and it will be more beneficial to the manufacturer.

In order to prove the correctness of the propositions and theorems, the following analysis and verification are carried out by means of numerical analysis.

5. NUMERICAL ANALYSIS

Considering that consumers have different consumption preferences for different channels, take consumer preference n for traditional channels as an independent variable to verify the correctness of the results of this paper. Suppose $a=800$, $b=0.2$, $\beta=3$, $\mu=6$.

As shown in Table 1, as consumers' preference n for offline channels increases, wholesale prices, offline retail prices, and retailers' efforts to make promotions e_r , all increase, and online direct sales prices and manufacturers' promotion efforts The degree of effort e_m at time decreases accordingly, which verifies Proposition 1 and Proposition 3. The wholesale price when the retailer makes a promotion effort is reduced, and the wholesale price when the manufacturer makes the promotion effort is increased, thus verifying Proposition 4. After the manufacturer or retailer made the decision of promotion efforts, offline retail prices have risen, and the increase rate when the retailer made the promotion decision was higher than the situation when the manufacturer made the promotion decision; on the other hand, the line The price of direct sales has also risen, and the increase when the manufacturer makes the promotion decision is higher than the increase when the retailer makes the promotion decision, thus verifying Proposition 5. Studying the demand situation of different channels, we can realize that the retailer's promotion efforts will increase the demand for offline retail channels, but will not affect the original consumer demand of the online direct sales channel; the manufacturer's promotion efforts will increase the demand for online direct sales channels, while the offline retail channels are less affected, and the demand has decreased, thus verifying Proposition 2.

Table 1 Optimal decisions under different channel preference

n	Mode	w	p_r	p_m	q_r	q_m	e_r	e_m
0.3	N	183.33	243.33	316.67	60	292	-	-
	R	138.58	490.05	371.58	351.48	286.43	175.73	-
	M	409.52	469.52	1447.6	60	1377.7	-	723.80
0.5	N	250	350	250	100	220	-	-
	R	216.39	528.57	327.87	498.36	215.08	249.18	-
	M	428.57	714.75	1142.9	100	1077.1	-	571.42
0.8	N	350	510	150	160	112	-	-
	R	333.11	1051.8	262.30	718.69	108.07	359.34	-
	M	457.14	617.14	685.71	160	626.29	-	342.86

5.1. The influence of consumer channel preference on total supply chain demand

It very well may be seen from Figure 2 that as long as a company in the supply chain makes a promotion decision, the overall performance of the system will improve. When $n \leq 0.78$, the promotion decision made by the manufacturer can obtain more consumer demand. At this time, online channels are more attractive to consumers, and the performance of the supply chain system is higher. When $n > 0.78$, the retailer's decision to make promotion efforts can obtain more consumer demand, because the retailer is closer to the consumer and can provide more in line with expectations. At this time, the traditional retail channel is more for consumers. Attractive, higher performance of the supply chain system.

5.2. The influence of consumer channel preference on manufacturers' profits

As per Figure 3, as long as the companies in the supply chain system make promotional efforts, the profits of manufacturers will increase. If only one side of the manufacturer or retailer is considered for promotion efforts, it can be known that when $n \leq 0.64$, online channels are more attractive to consumers at this time, and the manufacturer's profit for promotion is higher; when $n > 0.64$ At this time, consumers prefer to buy products offline. For manufacturers, it is more beneficial for the retailer to make sales promotion efforts. At this time, the manufacturer does not need to make additional promotion efforts, which verifies Theorem 5.

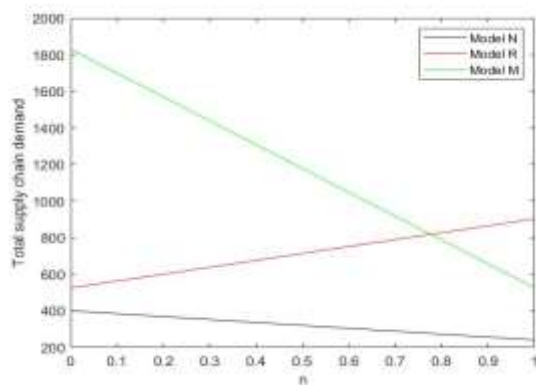


Figure 2. The impact of n on supply chain system demand

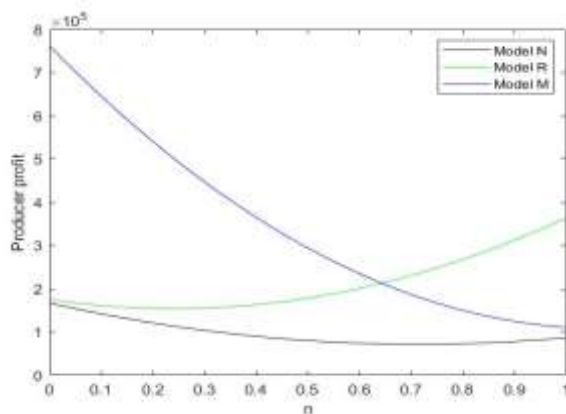


Figure 3. The impact of n on the profits of manufacturers

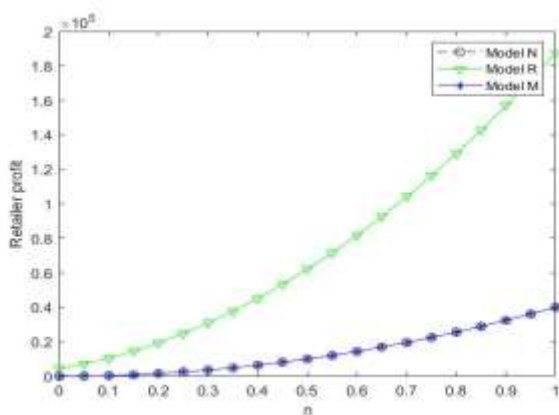


Figure 4. The impact of n on retailer profits

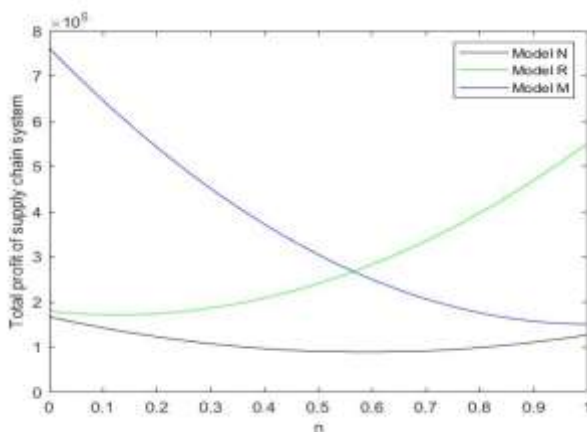


Figure 5. The impact of n on the profit of the supply chain system

5.3. The influence of consumer channel preference on retailer's profit

According to Figure 4, the retailer's profit always increases with the increase of consumers' preference for offline channels. When the manufacturer makes promotion efforts, it has little effect on the retailer's profit. When the retailer makes a promotional effort, the retailer's profits will increase. Therefore, the retailer has the tendency to make the promotion effort decision, which verifies Theorem 4.

5.4. The influence of consumer channel preference on the total profit of the supply chain

According to Figure 5, when a company member in the supply chain makes a promotion decision, the total profit of the system will increase significantly. If only the manufacturer or retailer is considered for promotion efforts, when $n \leq 0.56$, online channels are more attractive to consumers at this time, and the total profit of the supply chain where the manufacturer makes the promotion effort decision is greater. When $n > 0.56$, offline channels are more attractive to consumers at this time, and the total profit of the supply chain where the retailer makes the promotion effort decision is greater.

6. CONCLUSION

This paper concentrates on the effect of different promotion efforts on the profit and performance of the members of the dual-channel supply chain system. According to the difference between online and offline promotion initiators, there are three different models: manufacturers and retailers do not promote sales, retailers do sales alone, and manufacturers do sales alone. According to the Stackelberg game method, the optimal decision and optimal profit of the manufacturer and retailer under different promotion modes are obtained respectively, and the optimal decision and profit of the manufacturer and the retailer are compared and analyzed, and the optimal decision of the manufacturer and the retailer is obtained. Promotion strategy has important reference value and practical significance for the development of promotion strategy of dual-channel supply chain enterprises.

The conclusions of this paper are as follows: (1) Retailers have promotion motives: When a retailer makes a promotion effort decision, the manufacturer will lessen the wholesale price in order to alleviate the "double marginal effect". (2) For the manufacturer, the profit will increase if the manufacturer or retailer makes the decision of promotion efforts. (3) When online channels are more attractive to consumers, for manufacturers, their decision-making on promotion efforts will be more profitable, and at the same time, the supply chain performance level will be higher. (4) When traditional channels are more attractive to consumers, as far as manufacturers are concerned, the retailer's promotion efforts can make them more profitable, simultaneously, the performance level of the supply chain will be higher.

In addition, it is possible to further study the situation when manufacturers and retailers make promotional efforts at the same time, considering the asymmetry of demand information and random consumer demand and other special circumstances, the research on the profit and performance of the members of the dual-channel supply chain. This is also a direction worth studying in the future.

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APPENDIX

Proof of Theorem 1

The decision sequence of mode N is that the manufacturer first sets its own wholesale price w and the online direct selling price p_m , and then the retailer sets its own retail price p_r according to the manufacturer's decision.

Use the reverse derivation method to find the optimal solution:

First, the second derivative of the retailer's profit function Π_r to p_r is -2 , which shows that Π_r is a concave function and has a unique maximum value. Find the first derivative of Π_r and set it to 0 to obtain: $p_r = \frac{1}{2}(w + na + bp_m)$. Incorporate the above formula into the producer profit function Π_m , and obtain the Hessian determinant of Π_m with respect to w and p_m : $H(\Pi_m) = \begin{vmatrix} b^2 - 2 & b \\ b & -1 \end{vmatrix}$. From the formula, the first-order principal and sub-determinant can be obtained $H(\Pi_m)_{11} = b^2 - 2 < 0$, the second-order principal and sub-determinant $H(\Pi_m)_{22} = 2(1 - b^2) > 0$, it is known that the profit function Π_m is a concave function of w and p_m , and there is a unique maximum value. Next, Π_m is differentiated with respect to w and p_m , and the parallel equations are solved to obtain w^{N*} and p_m^{N*} . From this, theorem 1 in the text can be obtained.

Proof of theorem 2

The decision-making sequence of R mode: the manufacturer first sets its own wholesale price w and online direct selling price p_m , and the retailer then sets its own retail price p_r and effort level e_r according to the manufacturer's decision.

The optimal solution is obtained by inverse derivation:

Assume that the wholesale price w and the online direct selling price p_m are known, and then find the retailer profit function Π_r Hessian determinant of retail price p_r and effort level e_r :

$$H(\Pi_r) = \begin{vmatrix} -2 & \beta \\ \beta & \mu \end{vmatrix}$$

From the above expression, we can obtain the determinant h of the first-order principal sub form $H(\Pi_r)_{11} = -2 < 0$, the determinant of the second-order principal sub form $H(\Pi_r)_{22} = 2\mu - \beta^2$. Retailer profit function Π_r must satisfy $2\mu - \beta^2 > 0$ if there is an optimal solution. The first derivative of R with respect to p_r and e_r is set to zero, and the simultaneous equations are solved to obtain:

$$p_r = \frac{-w\beta^2 + \mu w + na\mu + b\mu p_m}{2\mu - \beta^2}$$

$$e_r = \frac{na\beta - w\beta + b\beta p_m}{2\mu - \beta^2}$$

Substitute the above formula into the profit function Π_m . Available Π_m is the Hessian determinant of p_m and w :

$$H(\Pi_m) = \begin{vmatrix} \frac{2\mu b^2}{2\mu - \beta^2} - 2 & b \\ b & \frac{-2\mu}{2\mu - \beta^2} \end{vmatrix}$$

From the above expression, we can obtain the determinant of the first-order principal sub form $H(\Pi_m)_{11} = \frac{2\mu b^2}{2\mu - \beta^2} - 2$,

determinant of second-order principal sub form $H(\Pi_m)_{22} = \frac{4\mu(2\mu - \beta^2)(1 - b^2) - \beta^4 b^2}{(2\mu - \beta^2)^2}$. If the profit function has an optimal

solution, there must be $H(\Pi_m)_{11} < 0$, $H(\Pi_m)_{22} > 0$; that μ , β and b must meet: $\mu b^2 < 2\mu - \beta^2$,

$4\mu(2\mu - \beta^2)(1 - b^2) - \beta^4 b^2 > 0$. Profit function at this time Π_m is a concave function, and the optimal solution exists and is unique. Separately Π_m with respect to the derivatives of p_m and w , p_m^{R*} and w^{R*} can be obtained by solving the simultaneous equations, thus theorem 2 can be obtained.

Proof of Theorem 3

The decision-making sequence of M-mode is that the manufacturer first sets its own wholesale price w , online direct selling price p_m and promotion effort level e_m , and the retailer then sets its own retail price p_r according to the manufacturer's decision.

The optimal solution is obtained by inverse derivation:

Firstly, the second derivative of Π_r to p_r is -2 , which indicates that Π_r is a concave function with a unique maximum.

Find the first derivative of Π_r and make it 0 to obtain:

$$p_r = \frac{1}{2}(w + na + bp_m)$$

Bring the above formula into the manufacturer profit function Π_m . Can be obtained Π_m the Hessian determinant of w , p_m and e_m :

$$H(\Pi_m) = \begin{vmatrix} b^2 - 2 & b & \beta \\ b & -1 & 0 \\ \beta & 0 & -\mu \end{vmatrix}$$

From the above expression, we can obtain the determinant h of the first-order principal sub form $H(\Pi_m)_{11} = b^2 - 2 < 0$, determinant h of second-order principal sub form $H(\Pi_m)_{22} = 2(1 - b^2) > 0$, determinant h of third-order principal sub form $H(\Pi_m)_{33} = \beta^2 - 2\mu + 2\mu b^2$, profit function Π_m is to have an optimal solution, then μ , β and b must be satisfied $\beta^2 - 2\mu + 2\mu b^2 < 0$, profit function at this time Π_m is a concave function with respect to w , p_m and e_m , and there is a unique optimal solution. Separately The derivatives of Π_m with respect to w , p_m and e_m can be solved by simultaneous equations to obtain $p_m^{M^*}$, w^{M^*} and $e_m^{M^*}$, thus Theorem 3 can be obtained.

Research on the application of smart supply chain finance in the financing of private scientific and technological enterprises in China

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ABSTRACT

Supply chain finance (SCF) has experienced the development stages of offline SCF, online traditional SCF, and Internet SCF, and has developed to the stage of smart supply chain finance (SSCF) driven by digital technology in China. We analyze the theoretical framework of SSCF model from three aspects: loose coupling alliance organizational structure, visual operation and management process and symbiotic multi-agent coordination mechanism. In the financing of private scientific and technological enterprises, SSCF will show smart effects such as intelligent decision-making, harmonious service, penetrating management and digital risk control. Further, the process of SSCF providing financing services for private scientific and technological enterprises is designed. Finally, in view of the problems and challenges faced by private scientific and technological enterprises in the application of SSCF, we put forward countermeasures and suggestions from the aspects of expanding the dimension of smart transformation, building a perfect regulatory system and legal system, and strengthening the cultivation of compound talents in this paper.

Keywords: Smart supply chain finance, Private scientific and technological enterprises, Digital technology.

INTRODUCTION

Private scientific and technological enterprises refer to knowledge intensive economic entities that take scientific and technological personnel as the main body, follow the principle of "Independent management, profit-and-loss responsibility", engage in technology development, transfer, consultation and service activities, and integrate production, sales and scientific research (Lu & Zhang, 2020). With the rapid development of economy and the continuous progress of science and technology, private scientific and technological enterprises have developed rapidly in China, playing an important role in stimulating economic growth, optimizing industrial upgrading, driving innovation strategies and so on. However, most private scientific and technological enterprises are difficult to obtain financial resources from formal financial institutions due to the inherent defects of less fixed investment, short operation cycle, large innovation investment and high operational risks. Many private scientific and technological enterprises rely on own funds for their innovation investment. The difficulty and high cost of financing are the pain points that have plagued the innovation and development of private scientific and technological enterprises for a long time (Dou et al., 2019). How to obtain financing efficiently, conveniently and safely has become the key to the high-quality development of private scientific and technological enterprises. Therefore, it is of great significance to actively open up new financing channels, break through financing bottlenecks, and provide high-quality financial support for the innovative development of private scientific and technological enterprises.

SCF is a financing mode that breaks through the weak credit of SMEs in the chain by using the energy diffusion effect of core enterprise advantageous resources in the industrial chain. It is a financing way tailored for private scientific and technological enterprises. However, traditional SCF has the disadvantage of single-layer credit transmission. A large number of private scientific and technological enterprises at the long end of the supply chain can't take advantage of the credit of focus enterprises, which limits the inclusive effect of SCF (Dou et al., 2019). There is an urgent need to innovate the SCF model and provide development funds for more private scientific and technological enterprises. Driven by emerging technologies such as big data, Internet of things, blockchain and artificial intelligence, SCF is undergoing intelligent transformation and ushering in the stage of SSCF (Song & Yang 2019). Sfar et al. (2018) proposed that SSCF should include the cooperation of supply chain management, efficient operation, predictive maintenance and inventory optimization. Wan et al. (2020) pointed out that AI, machine learning, big data computing and other technologies have promoted the development of SSCF. Song (2019) proposed that SSCF is to carry out financial services more efficiently, transparently and openly with the help of artificial intelligence, blockchain, cloud computing, big data and other technologies. To sum up, in essence, SSCF means that driven by new information technologies such as big data, Internet of things, blockchain, artificial intelligence and cloud computing, SCF is

highly integrated with financial technology, and provides more efficient, open and comprehensive new financing services for enterprise production and operation by virtue of digital transaction processes, visual operation management and intelligent financing decisions. SSCF will realize the deep integration of "intelligence + industrial ecology + modern finance", which can provide fast, convenient and affordable financial services for more private scientific and technological enterprises, and meet the needs of high-quality financial support for the innovative development of private scientific and technological enterprises.

We first analyze the development and evolution of SCF in this paper, study and define the theoretical framework of SSCF, and further discuss the innovative application of SSCF in private scientific and technological enterprises from the two aspects of the smart effect principle and operation design of SCF. Finally, in view of the problems and challenges that may exist in the application of SSCF in private scientific and technological enterprises, we put forward corresponding countermeasures, so as to provide decision-making reference for private scientific and technological enterprises to more effectively apply SSCF to alleviate financing difficulties.

THE DEVELOPMENT AND EVOLUTION OF SCF IN CHINA

SCF started at the beginning of the 21st century in China, and has experienced the traditional SCF stage and the online SCF stage. With the intervention of Internet technology, it has developed to the Internet SCF stage, which has made contributions to easing the financial constraints of SMEs, including private scientific and technological enterprises. Now, driven by the digital economy and financial technology, the development of SSCF has brought new opportunities for the financing needs of technology-based enterprises.

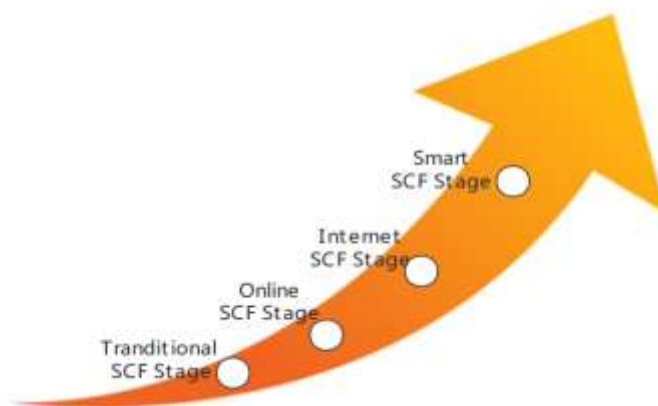


Figure 1: Development and evolution of SCF

Traditional SCF stage

SCF business can be traced back to the first cargo mortgage financing initiated by Shenzhen Development Bank (now renamed Ping An Bank) in Guangdong Province, China in 1998, and put forward the service concept and financial products of SCF in 2002. The real SCF business in China should begin with the strategic cooperation between Shenzhen Development Bank and the three logistics companies of China Foreign Trade Transportation Corporation, China National material storage and Transportation Corporation and China Ocean Logistics Co., Ltd. in 2005. Hundreds of enterprises obtained financing through SCF in more than a year, creating a high credit financing of 250 billion yuan. At this stage, the business of SCF is generally dominated by commercial banks, core industrial enterprises or an alliance of the two, and focuses on providing financial services for SMEs upstream and downstream of the supply chain based on the credit of the core enterprises of the supply chain. Limited by technology, the development means of SCF mainly rely on traditional paper media, so the service quality and efficiency of SCF are poor.

Online stage of traditional SCF

With the development of e-commerce, more and more enterprises begin online transactions. The traditional offline SCF services begin to encounter bottlenecks in many aspects, such as target customers, financing lines, financing frequency, credit conditions, rating mode and service efficiency, which urges the online expansion of SCF. In 2010, Shenzhen Development Bank took the lead in the online business model. In June 2012, China Construction Bank began to launch "Shanrong commerce". Various banks have launched e-commerce financial service platforms, launched online SCF services, developed supporting systems combined with SCF, realized docking with core enterprises, and input transaction data such as transactions, warehousing, logistics, payment, etc. into the system. Compared with the traditional SCF stage, the leading force, service content and service mode of online SCF business have not changed substantially. As the transitional stage from traditional SCF to Internet SCF, online SCF alleviates the asymmetry of information to a certain extent and improves the efficiency of financial services due to the application of network technology. However, at this stage, the transaction data of core enterprises are more involved. Banks and other financial institutions still have insufficient control over upstream and downstream enterprises. The real borrowing enterprises have not formed actual and effective data to control, so it is difficult to achieve a comprehensive risk assessment.

Stage of Internet SCF

The combination of SCF and Internet has greatly expanded the connotation and application scope of SCF, and SCF has begun to enter the stage of Internet development. In the stage of Internet SCF, leading institutions are no longer limited to commercial banks or industrial giants. e-commerce platforms, P2P platforms, third-party payment institutions and others have landed in the field of SCF, relying on their own advantageous resources to expand SCF business. With the vigorous development of e-commerce, the Internet SCF platform can monitor all kinds of transaction behaviors in the platform point-to-point, ensure the consistency of capital flow and transaction behavior, and provide a highly matched financing scheme based on the historical data precipitated by the transaction, combined with the financing transaction needs, risk preferences and other characteristics of both parties. Data such as e-commerce transactions, online payment, capital settlement and logistics management can realize high-level information sharing in Internet SCF, and promote the "four flows in one" of business flow, capital flow, information flow and logistics of SCF. Internet SCF presents a complex and interdependent ecological network structure, realizes the integrated management of horizontal and vertical industrial chains and service chains, and forms the ecosystem big data of transaction precipitation. However, with the continuous complexity of participants, trading behavior and risk control, the requirements for the accuracy, visualization and intelligence of Internet SCF services are becoming higher and higher, and there is an urgent need to add new generation technologies such as big data, Internet of things, blockchain and artificial intelligence.

SSCF stage

With the innovation and transformation of digital technologies such as Internet, big data, cloud computing and artificial intelligence, platform organizations based on new technologies continue to show a trend of integration and development with traditional industries, giving birth to new formats of digital economy (Zhang, 2019), promoting the multi-dimensional integration of SCF and digital technology, and promoting the development of SCF into an intelligent stage. According to the data of the "2019 China SCF Research Report", 55% of the surveyed enterprises applied big data and artificial intelligence technology, 44% applied cloud computing, 39% applied blockchain technology, 29% applied Internet of things technology, and only 13% did not use any financial technology. The wide application of various digital technologies in SCF marks that SCF has entered the stage of SSCF in China. At this stage, the participants of SCF are more diversified, and members of different types and different network locations form more complex dependencies, and support and control are achieved through the integration of digital technology (Song, 2019). From the perspective of theoretical research, scholars at home and abroad have begun to pay attention to the intelligent transformation of SCF and explore the function of digital technology in SCF. Previous studies have found that the application of big data in SCF helps identify enterprise credit (Jiang, 2015) and can play a unique advantage in risk control (Yan & Sun, 2015); The Internet of things is applied to the inventory pledge financing mode, which can reach the bottom business information of the supply chain (Wang et al., 2019); Blockchain technology has great potential in preventing transaction data tampering, breaking through credit limitations, reducing monitoring costs, etc. (Saber et al., 2019), is conducive to creating a more stringent regulatory environment (Sun et al., 2022), and expands its application in inventory financing, order financing, accounts receivable financing and other business areas (Hofmann et al., 2018).

THEORETICAL BASIS AND RESEARCH FRAMEWORK OF SSCF

Theoretical basis of SSCF

Long tail theory

Chris Anderson, an American Internet economist, mentioned in his book the long tail theory in 2004 that the focus of cultural economy is accelerating the shift from a few hot spots (mainstream products and markets) in the demand curve to a large number of niche products and markets at the end of the demand curve. The long tail theory believes that we should not only pay attention to the long tail goods at the head, but also pay attention to the tail goods that can meet the personalized needs. The profits brought by these tail goods add up, and even higher than the profits brought by the long tail market. The traditional credit model pays more attention to the large-scale core enterprises in the industrial chain, ignoring the private scientific and technological enterprises at the end of the supply chain, and the benefits brought by these enterprises are crucial to the sustainable development of the industrial supply chain. With the penetration and influence of digital technology in the SCF system, the ecological operation platform has built a data system based on the deep integration of industrial chain operation and financial information formed by digital trust. After private scientific and technological enterprises send out loan applications, the platform automatically reviews the information of their pledged assets, making the enterprise credit portrait more accurate. At the same time, banks can accurately grasp the structured credit of the supply chain, The convergence of various credit guarantee systems and social credit reporting systems has promoted the formation of third-party guarantee and credit enhancement schemes, expanded the credit enhancement of the SCF system to a greater extent, and all kinds of digital credit are integrated, which can be conducted and traced within the whole ecological community, creating financing opportunities for more long tail private scientific and technological enterprises at the end of the supply chain.

Theory of combination of industry and Finance

The combination of industry and finance, that is, the integration of industrial capital and financial capital, realizes the internal integration of economic operation through various forms such as participation, shareholding, holding, personnel participation and so on. As early as the end of the 19th century, European and American countries basically had no restrictions on the cross-industry business of commercial and financial institutions, but at that time, the industry was highly dependent on banks. After the reform and opening-up, real economic market and financial market have developed together in China, forming

a strong joint force. 1978 ~ 2001 was the initial stage of domestic financial integration in China. Enterprises obtained capital from banks through various forms of financing, which laid a solid foundation for the realization of "industrial and financial integration". The second stage is from 2002 to 2012. The financial market is diversified, and the financial means used by enterprises are more diversified. Through the combination of industry and finance, resources can be allocated effectively. The third stage is from 2013 to now. The combination of industry and finance has reached a new height of development. Financial innovation from theory to practice, diversified development of the combination of industry and finance, and continuous integration. SCF is a new model of the combination of industry and finance. In the context of the new economic era, the combination of industry and finance will be the main driving force for the new wave of rapid growth in China, and SCF is an effective way to promote the combination of industry and finance. Based on the real trade background between enterprises in the industrial chain, SCF relies on the advantageous resources of core enterprises in the supply chain to complete the inflow of financial capital into the real economy of the industrial chain, and realize the combination of industry and finance in which funds flow from finance to industry. The regulation and guidance of SCF policies have promoted the flow of financial capital to the industrial field, which can not only promote the transformation of finance from virtual to real, reduce financial risks, but also provide financial resources for the survival and development of real industries. SCF shows great market vitality in the continuous innovation and development. It will have a very positive significance in optimizing the industrial ecological environment, improving the financing channels of private scientific and technological enterprises, and improving the service methods of financial institutions.

Digital ecology theory

Digital ecology is a new form of economic organization formed after the deep integration of the real economy with big data, the Internet and artificial intelligence. With the help of big data and Internet technology, heterogeneous organizations such as private scientific and technological enterprises, financial institutions and other production-oriented service entities operate in the SCF ecosystem. On the premise of maintaining the ownership of the entities, they realize cross industry business reengineering through data fusion based on ecological contracts, form an organic whole of different entities with high efficiency and low cost, and realize the multi-agent joint operation of the ecological platform, innovate the new ecological mode of digital restructuring industry. On the one hand, it can gather private scientific and technological enterprises in the platform to jointly purchase, produce and sell, and make use of peer collaboration to improve efficiency and reduce costs; On the other hand, supply chain products are grafted to the ecological platform to enjoy all kinds of public services provided by the ecological platform, including finance, channels, after-sales, and obtain dividends from the complementarity of different industry alliances. Therefore, the digital ecological platform is not a simple information sharing platform, but a joint operation carrier deeply integrated with users. From the enterprise level, the ecological platform will connect all kinds of subjects who have transactions with private scientific and technological enterprises with new linking means to form a value cycle system; From the perspective of industry, the digital ecological platform reorganizes the advantageous resources of industry, service industry and agriculture to form an industrial integration mechanism; From a social perspective, the digital ecological platform will gather different economies across time and space and industries to form a collaborative symbiosis system. Meng et al. (2020) believe that the digital ecosystem is composed of central enterprises, digital populations and value communities, which organically cooperate to form a benign and efficient material cycle, information transmission and energy flow. Digital ecology plays an important role in integrating, deconstructing and reconstructing the industrial chain (Li, 2020) and promoting the deep integration of technology and the real economy (Qi et al., 2020).

Research framework of SSCF

The emergence of SSCF cannot be separated from the integration support of digital technology. Compared with traditional SCF, SSCF platform is more complex, intelligent and interactive, showing huge differences in structure, process and elements.

Organization structure of loosely coupled Alliance

Under the integration and synergy of various digital technologies, the participants of SCF have been greatly expanded. There are mutual influences and interactions between each participant. The whole SSCF presents an organization structure of loosely coupled alliance. Based on a good introduction mechanism, the platform has accumulated a large number of various participants with advantages in risk control, credit enhancement and capital. More and more third-party service roles continue to participate in SCF services, but the participation of each new business will not cause the change of the original business. The accumulation of a large number of advantageous resources has weakened the excessive dependence of private scientific and technological enterprises in the upstream and downstream of traditional SCF on focus enterprises, and business entities continue to tend to interact independently. Under the loose coupling structure mode, on the one hand, it has fully expanded network resources, stimulated market vitality, increased the number of transactions, and greatly expanded the depth and breadth of SSCF business. On the other hand, it makes the SCF platform environment more flexible and agile to meet various transaction needs, more convenient for system maintenance, and greatly improves the service quality and efficiency of SCF.

Visual process of operation management

With the continuous innovation and development of SCF, there are more and more factors that affect the operation of the supply chain. The variability of customer demand, the complexity of the supply network, sudden natural disasters, etc., have higher and higher requirements for the flexibility of the supply chain operation. Under the influence of new generation technologies such as big data, Internet of things, blockchain and artificial intelligence, SSCF can realize visual management from many aspects such as process management, warehousing management, logistics management and data management,

which greatly improves the flexibility of smart service of SCF. As shown in Figure 2, the visualization of process processing is reflected in the order processing, order checking, order realization, order arrival, etc. of private scientific and technological enterprises in the upstream and downstream of SSCF. Warehousing visualization: when warehousing, storage units are automatically allocated to trading products according to attribute elements, and when outbound, operators pick up goods from specific storage units. The visualization of logistics tracking management reflects the transaction time, transaction location, storage status, cargo dynamics and other information of different goods of multiple enterprises, so as to make a timely response according to specific needs. Data application visualization, the historical transaction information between enterprises can be intuitively reflected on the platform. The platform can collect and refine data according to the needs of financing enterprises, and then further count, analyze and generate data models to facilitate financing enterprises to make management decisions. The realization of visual operation management enables each transaction node to be monitored in real time, find problems in time, and solve problems effectively, which greatly reduces the overall risk of financial operation activities in the supply chain.

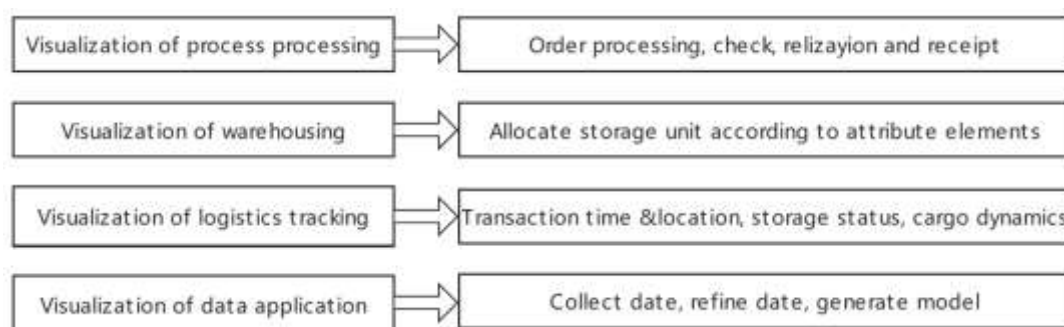


Figure 2: Visual process of operation management

Mechanism of symbiosis and coordination of multiple subjects

With the strong promotion of digital technology, the participants of SCF are becoming more and more complex, including ecological operation platforms of SCF, financial institutions, upstream and downstream private scientific and technological enterprises and other service providers. In the SCF ecosystem, various connection relationships, transaction relationships and collaborative relationships have been formed between private scientific and technological enterprises, financial institutions, ecological operation platforms and other entities and between the entities and systems by means of digital links, forming sticky and common vision goals based on symbiotic needs. In the operation mode of SSCF, private scientific and technological enterprises submit business applications to the SCF platform. The platform conducts data mining, collection, analysis and integration according to the transaction flow information of private scientific and technological enterprises, and submits the formed enterprise credit report to the fund provider for decision-making. Other service providers follow the corresponding intelligent contract according to the transaction instructions of the SSCF platform. Provide logistics, digital technology, infrastructure, industrial and commercial taxation and other services to the platform. Assist in financial risk identification, prevention and control, and ensure the efficient operation of financing activities. The essential object of SCF is capital. Under the multi-dimensional evaluation of borrowing enterprises by capital providers and the point-to-point monitoring of business activities by the SSCF platform, the authenticity, preservation and value-added of working capital in the business process are guaranteed. During the operation of SSCF, the interdependent integration of all parties involved, multiple participants go hand in hand, handle all financing links in SCF in a coordinated manner, and the whole process operates efficiently and orderly, jointly creating the ecological coordinated development of SSCF.

INNOVATIVE APPLICATION OF SSCF IN PRIVATE SCIENTIFIC AND TECHNOLOGICAL ENTERPRISES

Principle of intelligent effect

With the empowerment of digital technology, the operation activities and transaction nodes in supply chain can be truly and transparently reflected, which makes the credit differentiation and credit decision more intelligent. The transaction nodes of supply chain can realize penetrating monitoring and management. At the same time, improving the fair information platform has driven the efficient development between enterprises and the harmonious services of various public service institutions. The dynamic tracking of data makes the means of risk control further upgraded, so as to realize the intelligent effect of "intelligent decision-making, harmonious service, penetrating management and digital risk control", and timely and effectively solve the value demands of private scientific and technological enterprises. The key points of intelligent effect are shown in Figure 3.

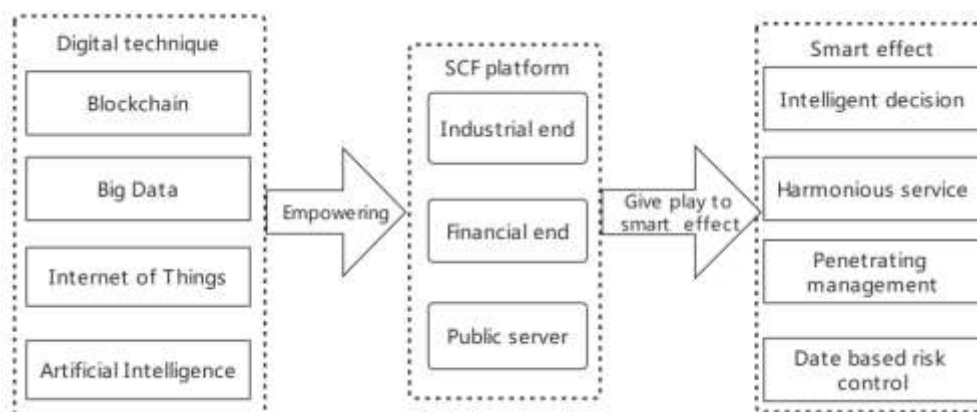


Figure 3: Smart effect of SSCF

Intelligent decision-making

The financing application of the SSCF platform for private scientific and technological enterprises first enters the intelligent screening mechanism, and enters the intelligent risk control system of the platform through the enterprise data information of the automatic screening system. The platform relies on own model of the risk control end and the embedding of external risk control services to jointly depict the accurate portrait of private scientific and technological enterprises, which is stored in the proprietary system of the platform risk system. The credit enhancement system enters the intelligent credit enhancement mode for the data information transmitted by the risk control end, completes the credit guarantee of private scientific and technological enterprises by means of credit enhancement configuration, credit guarantee, smart contract and so on, and stores the output information in the proprietary system of the credit enhancement system to provide credit support for the decision-making and credit granting of financial institutions in the next stage. The financing final settlement system intelligently selects the optimal financing scheme through the fund allocation system, issues instructions to the corresponding fund supply system, and completes the distribution and recovery of funds through the automatic credit extension and collection system. This series of intelligent financing means improves the operation efficiency, greatly reduces the occurrence of financial risks, and ensures the effective return of funds.

Harmonious service

More and more participants continue to join the camp, and SSCF has formed a large financing operation platform. At this time, SSCF is not only a traditional value-added chain, but gradually evolved into a cooperative chain of benefit sharing and risk sharing. Therefore, reasonable transactions and fair operating rules are very important for the whole SSCF, especially for emerging enterprises such as private scientific and technological enterprises that attach great importance to data information. A perfect and fair information platform will drive the harmonious and efficient development among enterprises. By building a high-level information sharing center and formulating a fair and equitable benefit distribution mechanism, the SSCF platform can comprehensively measure the investment products and financing needs with the help of the information platform, excluding enterprises that do not comply with the financing rules and credit, overcoming the imbalance caused by the allocation of power or resources, and effectively preventing the occurrence of moral hazard and speculation. Therefore, the harmonious service of SSCF realizes business interoperability, data availability and resource sharing, promotes the value creation and benign interaction between investment and financing parties, and achieves efficient coordination, harmony and win-win results.

Penetrating management

Traditional SCF is difficult to grasp the complicated operation state, especially at the far end of SCF. The expansion and application of digital technologies such as blockchain, big data, Internet of things, artificial intelligence and cloud computing have made private scientific and technological enterprises at all nodes of SSCF gain penetrating control. Big data modeling can provide private scientific and technological enterprises with qualification screening and accurate portrait services, so as to have a more comprehensive grasp of information of the traders and help them identify corporate credit. The combination of Internet of things and SCF mainly uses sensing technology, navigation technology, positioning technology and other methods to identify information, which is conducive to reaching all kinds of business information. Full process tracking management, automatic monitoring of warehousing and freight links to control the transaction process, so as to improve the authenticity of terminal transactions. As a distributed ledger database, blockchain technology makes use of the characteristics of distributed data storage, point-to-point transmission, consensus mechanism and so on, so that the information of the intermediate links of transactions between private scientific and technological enterprises can be traced. AI collects the business information of each scenario of the enterprise through sensors or manual input, intelligently analyzes and compares it with the stored information, and describes various possible implementation schemes, which saves the consumption of human and financial resources to a certain extent. The application of the above digital technology realizes the penetrating monitoring and management of each transaction node in the supply chain, and greatly improves the overall service quality and efficiency of SSCF.

Data based risk control

With the help of financial technology, in the SSCF system, through automatic and intelligent collection, analysis and processing of data information, improve information abundance and reliability. Big data can help the SSCF platform master the financial data, transaction data, industrial and commercial registration data, tax payment data, customs data and individual credit data of private scientific and technological enterprises, improve the ability of risk identification and simplify the risk process. The use of Internet of things technology can help the SSCF platform to dynamically track all participants. When national policies are adjusted or the market is impacted, it can timely know the changes in the business status of all participants and formulate risk response strategies in advance. At the same time, Internet of things technology can effectively build the cooperative relationship between the upstream and downstream of private scientific and technological enterprises through data information, so as to reduce the risk caused by the unstable relationship between enterprises in the supply chain. The incorrigibility of blockchain technology permanently stores information and data (Huang *et al.*, 2018) which will not be lost in the transaction link, and is transparent and traceable, ensuring the security and stability of data. Digital risk control provides the intelligent SCF platform with accurate identification of financial risks, and timely and effectively avoids the occurrence of financing accidents.

Operation design of SSCF

The penetration of digital technology has brought great changes to SCF. With the technological empowerment of blockchain, Internet of things, big data and other technologies, the credit enhancement, risk control and capital advantage resources attracted by the platform have brought diversified services to private scientific and technological enterprises on the platform, and the original complex and cumbersome financing process has become more efficient and convenient. private scientific and technological enterprises rely on their creditor's rights, physical or intangible assets, through the credit evaluation, risk rating and supply and demand distribution of the platform, to increase their credit and match the appropriate capital port to obtain financing funds; At the same time, the SCF platform uses the synergy of blockchain, big data, Internet of things and other technologies to provide intelligent risk management for financing services; The future sales or intangible asset transfer fees of private scientific and technological enterprises enter the SCF platform as a source of repayment, and the platform realizes automatic allocation of funds through intelligent payment and settlement. The specific process is shown in Figure 4.

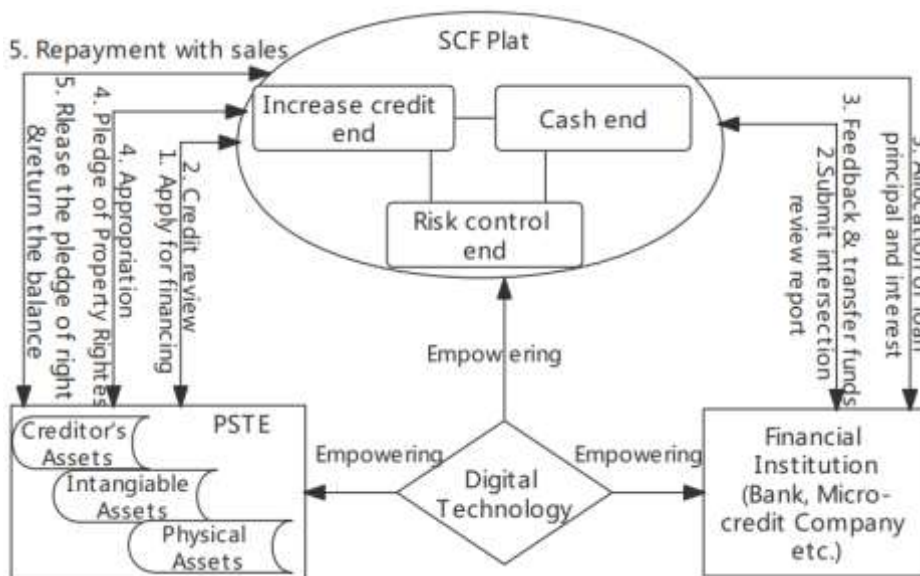


Figure 4: Operation process of SSCF

The operation process of SSCF is shown in Figure 4. First, private scientific and technological enterprises with creditor's rights assets, physical assets or intangible assets submit relevant purchase and sales contracts or asset certificates to the SCF platform and file financing applications. Second, the platform captures the circulation and transaction information of private scientific and technological enterprises through blockchain, big data and other technologies, and uses its own model to extract, integrate and analyze the data with the help of cloud computing to form a risk rating; Then, the evaluation information is transmitted to the credit investigation and evaluation institutions on the SCF platform, as well as the public utility systems such as the tax bureau and the administration for industry and commerce, to make credit evaluation reports and compliance guarantees for private scientific and technological enterprises; Further, according to the risk rating and credit evaluation, the financing needs are divided into appropriate financial institutions, and the credit review report is submitted. Third, financial institutions conduct multi-dimensional evaluation based on the offline credit status of private scientific and technological enterprises, provide financing credit to private scientific and technological enterprises, make credit decision feedback and allocate funds to the SCF platform. Fourth, agricultural enterprises pledge their sales claims, inventory possession rights or intangible asset use rights to SCF platforms. The platform will distribute funds to private scientific and technological enterprises; At the same time, the risk control end uses the Internet of things and artificial intelligence technology to continuously supervise the pledged assets and

share real-time data with financial institutions. Finally, the future sales payment or intangible asset transfer fee of private scientific and technological enterprises enter the capital end of the SCF platform through the smart contract signed with the platform. The platform automatically transfers the loan principal and interest to the account of financial institutions, collects a certain handling fee, returns the remaining amount to private scientific and technological enterprises, and removes the pledge of rights.

SSCF is based on the real business background to finance private scientific and technological enterprises that meet the pledge conditions. The platform uses digital technology to respond in a timely manner, cooperates with logistics enterprises, asset evaluation institutions and financial institutions to make online financing instructions in an orderly manner at every step, and carries out real-time dynamic monitoring of the business activities of private scientific and technological enterprises. The application of emerging communication technologies is in line with the characteristics of "short, frequency and fast" of private scientific and technological enterprises. It should be noted that in the SSCF platform, the risk control end will describe the risk characteristics of private scientific and technological enterprises, the credit enhancement end will describe the credit characteristics of private scientific and technological enterprises, and the capital end will provide the results of supply and demand matching for both parties of capital lending. Risk profile, credit characteristics and capital matching results are important basis for financial institutions to make credit decisions. Therefore, with the integration and support of a variety of digital technologies, the risk control end, credit enhancement end and capital end that absorb a large number of advantageous resources are the key control points for the operation of the SSCF platform, and also an important guarantee for the benign operation of SSCF.

COUNTERMEASURE FOR PRIVATE SCIENTIFIC AND TECHNOLOGICAL ENTERPRISESTO APPLY SSCF

Theoretically, with the empowerment of digital technology, SSCF can play an intelligent role in intelligent decision-making, harmonious service, penetrating management, and digital risk control. However, at present, whether at the organizational level or the supply chain level, the healthy operation of SSCF still faces great challenges. This challenge may come from the defects of knowledge, organizational structure or process design required for the successful implementation of SSCF within the organization, or may be related to external technical support, operation region and cultural complexity. The challenges faced by private scientific and technological enterprises in applying SCF are mainly manifested in three aspects: insufficient application of digital technology, imperfect institutional environment and serious lack of compound talents. The dynamic changes of these challenges will bring difficulties to the management, control and strategy implementation of SSCF. Therefore, this section puts forward the following three countermeasures and suggestions:

Expand the dimension of intelligent transformation

The intelligent transformation of SCF is essentially a new way for SCF to achieve exponential growth. Therefore, intelligent transformation is the only way for SCF to maintain agility and deepen competitiveness. Song(2020) divided SCF into traditional online SCF mode, circulating digital SCF mode, integrated digital SCF mode and integrated digital SCF mode according to the differences in the breadth and depth of application of SCF in digital platforms. Among them, the integration mode requires SCF to be relatively strong in the breadth and depth of application of digital technology. Intelligent SCF requires the application of digital technology to expand infinitely in the platform, covering all kinds of service providers and enterprises at all levels of the supply chain, and the digital technology should be deeply integrated with the industry, sink into all transaction links and processes of the participants, and ensure that the data of the whole chain is unobstructed and unblocked. In the process of digital transformation of SCF, having a large amount of data is the foundation. Understanding the development trend of digital technology is only the initial stage of intelligent transformation. Using strategic data management methods such as management, governance and mobile to convert data into insight, and then converting insight into action under the guidance of correct data strategies is the key to the success of intelligent transformation. This requires that SCF must rely on low-level and cutting-edge technologies and high-level digital tools and products to make breakthroughs in digital accuracy.

Establish a sound regulatory system and legal system

Building a sound regulatory system and legal system and other institutional environment is an important guarantee for the high-quality service of SSCF and the innovative development of private scientific and technological enterprises. From the perspective of the subject supervision system, the access mechanism of the SCF platform is the basis of the whole supervision system. The strict control of the access link can not only exclude some financing subjects with poor credit, but also carefully check the business qualifications of various service providers. Among them, for service providers of core modules such as risk control end, credit enhancement end and capital end, relevant laws and regulations require licensed services, such as payment and settlement, fund-raising, loan issuance and third-party guarantee, must be provided by licensed institutions; For businesses that do not strictly require licensed services in relevant regulations, such as technical services and post loan management, licensed institutions can cooperate with non-licensed institutions with professional advantages, in which licensed institutions are the key regulatory objects. The regulatory authorities can also expand the scope of supervision according to relevant regulations and cooperate with the SCF platform to supervise and inspect non licensed institutions. From the perspective of legal system, on different nodes of the SCF platform, different service providers responsible for risk control, credit enhancement and capital give full play to their respective professional advantages to jointly realize the innovation of SSCF model. However, in terms of risk sharing, clear unified norms and legal relations have not yet been formed. Therefore, clarifying the legal relationship of the participants and standardizing the behavior of the participants are the core issues to

ensure the good operation of the SSCF platform. At the same time, the wide application of digital technology in SCF urgently requires relevant laws and regulations to formulate corresponding legal standards for technical service institutions in terms of digital business qualifications, strengthen the formulation and improvement of relevant laws and regulations, and promote the standardized development of SSCF mode from the legal system.

Strengthen the cultivation of compound talents

Talent support is one of the key factors in the development of SSCF. All sectors of society should focus on strengthening the cultivation of compound talents and opening up channels for talent flow. First of all, from the government level, it is necessary to formulate and implement the development strategy of SCF talent construction from the top, formulate the training plan of leading talents in SCF, build a perfect talent training system of "supply chain management + modern finance + digital technology", and rely on universities and scientific research institutions to increase the training of professional and compound talents. At the same time, we should carry out or participate in international academic exchanges with an open attitude, actively absorb the advanced ideas of foreign SCF development and the innovative experience of science and technology, encourage enterprises to strengthen the effective output and learning of backbone personnel, and introduce high-level SCF compound talents to the world. Second, explore the cooperative training mode of "industry university research" in SCF. Promote social training institutions to strengthen exchanges and cooperation with enterprises and universities, realize the effective connection between enterprises, universities and scientific research institutions, build a SCF industry university research cooperation base, and improve the application and transformation ability of scientific research achievements in enterprise practice. Third, we should give full play to the important value of the SCF business to the continuous cultivation of talents. Enterprises should always adhere to the business philosophy of relying on talents for development, increase investment in talent construction, create favorable conditions and attract high-end talents. All kinds of enterprises, especially the core enterprises in the supply chain ecological environment, should build a good SCF talent training platform, a platform for talents to display their talents, optimize the talent development environment, based on enterprise practice, cultivate SCF elite talents, and create conditions for the benign operation of SSCF in China.

CONCLUSION

SCF has experienced the development stages of offline SCF, online traditional SCF, and Internet SCF, which has made contributions to alleviating the innovative development of private scientific and technological enterprises in China. However, with the transformation of China's economy from high-speed growth stage to high-quality development stage, higher requirements are put forward for the high-quality development of private scientific and technological enterprises. The high-quality development of private scientific and technological enterprises needs high-quality finance to support. Therefore, based on the background of the digital economy era, we propose a SSCF service model in this paper, and analyze the long tail theory, the combination of industry and finance theory and the digital ecology theory, which are the theoretical basis for the application of SSCF. We also focus on combing the theoretical framework of s SSCF from three aspects: loose coupling alliance organizational structure, visual operation management, and coordination element mechanism. Further, it explores the intelligent effect of "intelligent decision-making, harmonious service, penetrating management, and digital risk control" in the application of SSCF in private scientific and technological enterprises, and makes an innovative design for the operation process which private scientific and technological enterprises put to use SSCF. Finally, in view of the problems and challenges of SSCF in technology application in China, laws and regulations and talent construction at this stage, we put forward countermeasures and suggestions to expand the dimension of smart transformation, build a perfect regulatory system and legal system, and strengthen the cultivation of compound talents in this paper.

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Research on the impact of securities liquidity on momentum investment strategy returns

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ABSTRACT

During the "14th five-year plan" period, financial services were actively integrated into the new business forms of e-commerce development, in which financial investment vigorously promoted the efficient allocation of capital elements, so as to construct a service system suitable for the development of e-commerce, it is not only an important opportunity to meet the needs of the digital economy and expand its own development space, but also provides strong support for the high-quality development of e-commerce. Momentum strategy is a classical Behavioral finance investment strategy. Securities liquidity is the key factor affecting the return of momentum strategy. Based on this, this paper studies the impact of securities liquidity on momentum investment strategy returns by using empirical analysis. we find that the impact of securities liquidity on portfolio returns is different with the change of investors' holding period, and the momentum winner portfolio and loser portfolio returns are asymmetric under the influence of liquidity. The results of this study not only provide alternative paths for the practitioners to choose more effective momentum investment strategies, but also facilitate the deep integration of e-commerce and financial services from the perspective of investment.

Keywords: Momentum strategy, liquidity of securities, portfolio return, electronic commerce.

INTRODUCTION

Since securities investment came into being, it has promoted the reform of our economic system. The boom in e-commerce in recent years has brought many opportunities to financial innovation. Looking into the future, whether our country wants to successfully build an independent economy or E-commerce and financial formats should be integrated developed, it will undoubtedly need the support of securities investment, and the Securities Investment Market can play a full role as the premise. This requires a large number of securities investors to intervene in the securities market to invest in securities. However, investors are intrinsically motivated to enter the securities market to make a profit. Under the background of non-strong efficient market in our country, many investors have been inclined to use momentum strategy to invest in the market to obtain more considerable investment returns. With the confirmation of momentum effect in financial markets, the construction of momentum portfolio has developed rapidly, and the construction and optimization of portfolio is a long-term research hotspot in security market.

However, looking at the returns of momentum investment strategies in the current market, they are often unsatisfactory. The reason is that the effectiveness of momentum strategies is affected by many factors. Simply considering price momentum strategies may not be able to achieve profits. Among the many influencing factors, the liquidity of assets and transaction costs are the most important, that is, the liquidity of securities. Securities liquidity not only plays the core role of market efficiency, but also is an important basis for evaluating the value of securities, which directly reflects the development quality of the securities market (James, 2020). Analyzing the impact of momentum portfolio returns is inseparable from the study of liquidity.

Theoretically speaking, the current scholars' research focuses on the optimization of momentum strategies, but few people analyze its internal connection with momentum investment based on liquidity (May & Hassan, 2018). Even though a few literatures discuss the impact of liquidity on asset returns, more Regarding the impact of the pricing of the asset itself (Ea & Sa, 2019), there is a clear difference between investors using momentum strategies to make profits. From the perspective of liquidity, it is essential to optimize momentum investment strategies and analyze the impact of liquidity on the returns of momentum strategies. This study just makes up for the lack of empirical support in existing theoretical studies.

This paper studies the specific impact of security liquidity on the return of momentum portfolio constructed with it. First of all, in theory, momentum investment strategy belongs to behavioral financial decision-making theory, and liquidity is the microstructure of the market. This paper innovatively combines market microstructure and behavioral financial decision-making to promote the integration of the two theories, forming an interdisciplinary and expanding Research perspective. Secondly, there are few relevant literatures focusing on the impact of securities liquidity on the returns of momentum investment strategies, and the relationship between the two is still being explored. This study not only enriches the research in the field of momentum investment strategies, but also expands the existing research results, and combine the two, compared to the previous case where momentum investment strategy and liquidity were discussed separately, to deepen the research topic and make up for the insufficiency of existing research. Thirdly, practically speaking, it can help investors build better

momentum investment strategies on the basis of considering liquidity, obtain more considerable investment returns, and drive investors to actively participate in the financial market, thereby promoting the prosperity and development of the financial market and better promoting the electronic business financial service level.

RELATED THEORETICAL BASIS AND LITERATURE REVIEW

Theoretical basis

Efficient market hypothesis

In traditional financial theory, investors are completely regarded as rational people. They always make their own decisions with the goal of maximum utility, so that the entire market has no room for speculation, it is a strong and efficient market, namely the Efficient Market Hypothesis (Fama, 1970). All information contained in securities is already reflected in prices, and market participants cannot use market information to predict securities returns to act. The traditional efficient market hypothesis is an ideal state, which includes two assumptions: one is that security prices follow random walks in the market, and market participants cannot obtain excess returns; the other is that the real value of assets can be fully reflected in security prices. However, with the emergence of behavioral finance, it has brought a huge impact on traditional financial theory. The theory proposes that investors cannot be completely rational and that markets are not completely efficient (Thaler & Richard, 2016). The cognitive and behavioral biases that exist in the market can be exploited by investors, and the corresponding strategies can be used to obtain excess returns. Momentum investment strategy is one of the important methods.

Momentum Effect and Investment Strategy

The momentum effect is the inertia effect, which refers to the current stock price fluctuation trend, which is the continuation of the short-term movement trend in the past. During a given observation period, stocks that rose in the past continued to rise in price in the following period, and stocks that fell in the past continued to decline in price in the following period (Sharma & Jain, 2020). The so-called momentum strategy uses the inefficiency of the market to buy securities with better returns in the past short-term and sell securities with poor returns in the same period. In practice, this investment model is often referred to as "Chase up and down". The irrational behavior of investors has led to the underreaction of the market, and the changes in the intrinsic value of securities cannot be reflected from the fluctuations of securities prices. However, as time goes on, more information is reflected in the public eye, and after the perception of market participants is corrected, the price will gradually return to the range that reflects the normal intrinsic value, and the prices of securities that were once depressed will rise again. Investors using the momentum portfolio strategy use this process to obtain excess market returns through a series of buying and selling operations.

Securities liquidity

In 1936, in Keynes's description of the characteristics of money, the concept of "liquidity" first appeared in the academic field of view. After that, liquidity factors began to be considered in many fields such as financial management and macroeconomics. Liquidity includes transaction cost, price range, transaction time, price level and other characteristics, rich in connotation, and can be analyzed from multiple perspectives to analyze the connotation of liquidity (Apergis et al., 2015). Liquidity includes transaction cost, price range, transaction time, price level and other characteristics, rich in connotation, and can be analyzed from multiple perspectives to analyze the connotation of liquidity. There are various measurement methods. It gives a unified standard definition, but scholars generally believe that it can be measured from various perspectives such as depth, width, and breadth. According to the summary of the liquidity characteristics of securities by many scholars, this paper defines it as the ability of financial assets to trade at reasonable prices in a short period of time. The vital vitality of financial markets is reflected in the liquidity of securities. At present, the effectiveness of the momentum investment strategy in the Chinese market is controversial, mainly because the momentum investment strategy will be affected by a variety of factors, and against the background of our country's non-efficient market, securities liquidity has become a key factor affecting the momentum investment strategy, and Momentum portfolio returns are closely related.

Literature review

A Review of Research on Securities Liquidity

Up to now, there is no unified measurement standard for securities liquidity (Ruenzi., 2020). Various scholars select or compile liquidity indicators according to their own research paths. The literature on the relationship between securities liquidity and yield can be seen earlier in foreign countries. Scholars Amihud and Mendelson (1986) first measured market liquidity and obtained similar market phenomena: As market liquidity decreases, the overall return on the securities market increases. In terms of individual stocks, stocks with high yields tend to perform worse in their own liquidity. Later scholars discussed the introduction of liquidity into the well-known mean-variance framework of portfolio selection, demonstrating the powerful effect of liquidity on optimal portfolio selection. In particular, portfolio performance, as measured by the Sharpe ratio relative to the tangent portfolio, varies significantly with liquidity. In recent years, scholars have continued to explore more aspects of liquidity and demonstrated that liquidity produces cross-sectional changes in stock returns, and that less liquid stocks can be compensated with higher liquidity premiums. Although the liquidity standard measurement index system has not yet been formed, the significance of its impact on investment returns has been reflected many times in a large number of academic studies. However, the existing research results are mostly attempts to compile a more complete liquidity The index system or the study of the relationship between liquidity and portfolio returns has rarely paid attention to the impact of securities liquidity on the returns of momentum investment strategies. The academic community's analysis of the relationship between liquidity and momentum investment portfolio returns remains to be studied.

Research Review on Momentum Investing Strategies

Foreign researchers generally believe that momentum investment strategy used in the stock market will effectively achieve the expected return. Jegadeesh and Titman (1993) were the first to demonstrate the existence of momentum investment opportunities in the stock market. Rouwenhorst (1998) takes the market data of many European countries as the sample, through the empirical analysis, proves that the momentum effect generally exists in the European market. Subsequently Hameed and Kusnadi (2002) also demonstrated that momentum effects are indeed prevalent in Asian markets. Domestic scholars have conducted empirical research on the momentum strategy and found that the RMB-based currency momentum strategy produces an excess return of up to 5% per year, and the momentum strategy is more profitable under the high volatility of the Chinese stock market (Hsu & Chen, 2021). The effectiveness of momentum strategy is affected by many factors, among which the liquidity of assets is very important. Lee and Swaminathan (2000) introduced the liquidity parameter into the interpretation of momentum trading and reversal trading and found that there is a relationship between turnover and momentum strategy returns in the same direction. Subsequently, when Hvid kjaer (2006) studied the different performance of momentum portfolio strategies under different trading volumes, he also concluded that the size of trading volume had a certain impact on the returns of momentum investment strategies. Some domestic scholars (Deng et al., 2021) use the turnover rate as a liquidity indicator. The study found, the stocks with high turnover rate and the stocks with low turnover rate showed different characteristics, and the stocks with low turnover rate showed a higher turnover rate. More pronounced momentum effects; stocks with high turnover exhibit more pronounced reversal effects than low turnover.

Scholars' previous studies have mainly focused on the impact of liquidity on investment returns. However, most studies only roughly introduce liquidity variables to explore the impact on asset prices, and few studies consider the relationship between liquidity and momentum investment strategies. Therefore, it is extremely necessary to introduce securities liquidity and study its specific impact on investment strategies. Although no studies have shown the exact impact of liquidity on momentum portfolio returns, there is literature exploring the impact of liquidity on investment returns, such as some studies have demonstrated that a more liquid stock portfolio, the excess return is smaller (Bailey & Gilbert, 2007). Other scholars have found that different points of view, that is, low market liquidity period and low market returns coincide with the period (Hameed & Viswanathan, 2010). Therefore, we will make assumptions about the impact of stock liquidity on momentum portfolio returns based on the previous theoretical relations.

RELATED THEORETICAL BASIS AND LITERATURE REVIEW

The former shows that the study of the impact of securities liquidity on momentum portfolio returns has both theoretical research value and long-term practical significance, while the exploration of its specific impact must be constructed momentum portfolio, measuring portfolio returns and portfolio liquidity is also essential. Based on the above, this chapter constructs the momentum investment strategy, selects each measurement index, and establishes the empirical research model, which paves the way for the further empirical analysis.

Momentum portfolio and its yield

The study used a sample of CSI 300 Index stocks. The CSI 300 Index is a representative sample of 300 stocks listed on the Shanghai and Shenzhen Stock Exchanges. As a research sample, it can fully represent both the Shanghai and Shenzhen stock markets and fully reflect the historical changes in the stock market, also used in the current academic research stocks, securities and other market returns. According to the return rate of the CSI 300 underlying stocks in the past J weeks, that is, through the rise and fall of the formation period, the sample data is sorted from low to high, and the top 10% of the stocks are selected as the winner portfolio, After the formation period Buy and hold, the bottom 10% of the stocks are losers, and they will be short and sold after the formation period. All of the stocks in the portfolio are selected with equal weight, and do not weighted processing, to build a momentum portfolio, calculate the yield of different forming period and holding period respectively.

Based on the research standard of Robert et al. (2004), the grouping ratio of winner portfolio W and loser portfolio L is taken as 10%, which is helpful for the following scholars to compare and analyze the different research results at home and abroad. Forming period J selects 1-30 weeks, holding period K selects 1,2,3 weeks as momentum portfolio strategy under different time combinations, forming 90 portfolios. For brevity of description later, we defined J and K as (1-30,1) short-term holding portfolio and J and K as (1-30,2) medium-term holding portfolio, respectively, J and K for (1-30,3) are defined as portfolio of long-term holdings.

Stock yield is the total return on an investment in a stock/100% of the initial investment, reflects the level of return on the stock. For the momentum portfolio, we can use the average rise and fall of 60 stocks as the Index of portfolio return because of the selection of the average weight of individual stocks in the portfolio.

Measure of liquidity

Turnover rate = trading volume/outstanding share capital*100%. The higher the turnover rate, the shorter the time investors hold the security and the more frequently the stock trades, thus the better the liquidity of the stock. Many scholars at home and abroad often use turnover rate to measure the relationship between securities liquidity and securities returns, which provides a lot of theoretical basis for this paper. Therefore, this paper chooses the daily average turnover rate of the underlying CSI 300

Index starting from December 30, 2019, over the different weeks of the observation period as the basis for measuring the level of liquidity of the securities, and then explore the specific impact of securities liquidity on portfolio returns.

Construction of empirical model

In order to study the relationship between the liquidity of securities and the return of momentum portfolio, this paper takes the return of momentum portfolio under different formation periods as the explained variable (γ), and the liquidity of securities is measured by the turnover rate (T), as an explanatory variable, the rest of the factors are assigned to random disturbances (ξ) to complete the study, this paper proposes the research hypothesis:

H0: Securities liquidity has no effect on momentum strategy return.

H1: Securities liquidity has a positive correlation with momentum investment strategy return.

H2: Securities liquidity has a negative correlation with momentum investment strategy return.

H3: Securities liquidity has an impact on momentum investment strategy return but no specific correlation.

To test these hypotheses, a regression model was constructed:

$$\gamma = \beta T + \xi \quad (1)$$

γ stands for momentum portfolio return, β is the parameter to be estimated. This paper will focus on the β and the size of the positive and negative to get the impact of stock liquidity on the momentum investment strategy and how the specific impact. T is the average daily turnover rate of momentum portfolio in different formation periods, ξ is a random perturbation term.

AN EMPIRICAL TEST OF THE IMPACT OF SECURITIES LIQUIDITY ON THE RETURN OF MOMENTUM INVESTMENT STRATEGIES

Data selection and standardization

Sample selection

The data in this article comes from the choice data of Oriental Fortune. The selected research period is from December 30, 2019, to August 23, 2020, for a period of 30 trading weeks (excluding the Spring Festival non-trading week), excluding ST/*ST/PT stocks and stocks that were suspended during the period were excluded from the constituent stocks with completely missing data in each week. (Please see Appendix A for sample data normalization results)

Table 1: Descriptive statistical analysis of yield

Mean	0.0181
Standard error	0.0034
Median	0.0202
Mode	0.0407
Standard deviation	0.0557
Variance	0.0031
Kurtosis	0.6253
Skewness	0.0746
Domain	0.3339
Minimum	-0.1347
Maximum	0.1992
Sum	4.8960
Number of observations	270.0000
Confidence (95.0%)	0.0067

Through the above data analysis can be easily obtained, all portfolio turnover rate of the highest value of 3.38%, the lowest value of 2.12%, the rest of the portfolio are in between the two values, it can be seen that the overall liquidity volatility is not large. In the first 5 weeks, the winner of the portfolio and the loser portfolio is not equal, the loser portfolio performance slightly inferior. For the 90 different portfolios, 34 of them showed negative returns.

Take the case of J and K (1,1) for example. Starting December 30, 2019, buy 30 stocks in the top 10% of the CSI 300 Index, in order of return over the course of a week, at the same time, the 30 stocks of the latter 10% are short sold, and the daily average turnover rate of the 60 stocks is equal to the weight average during the forming week, to get the measure of liquidity of the whole momentum portfolio. Change the value of different J and K, and cycle back and forth. Then we get 30 different formation period exchange rate and yield under 3 different holding periods and test the significance of the relationship between the liquidity of each portfolio and the return of the portfolio.

The empirical results of the impact of liquidity on momentum portfolio returns

short-term holding portfolio

The momentum portfolio returns and turnover datas of 30 different formation periods, J and K (1-30,1), were imported into EViews. 8. The results of regression analysis are as follows:

Table 2: Short-term holding portfolio regression results

Variable	Coefficient	Std.Error	t-Statistic	Prob.	R ²	F-Statistic
T ₁	-1.7379	2.3741	-0.7320	0.4702	0.0188	0.4702
C ₁	5.8353	6.4822	0.9002	0.3757		

Table 3: Short-term holding portfolio ADF unit root test

	t-Statistic	Prob.
ADF unit root test	-2.1494	0.0325*

Note:***, **, *means significant at 0.001 , 0.01 , 0.05 level

From the statistical test, the P value of T1 is about 0.4702, which is greater than 0.05. Currently, the correlation between turnover rate and return rate is not significant.

The ADF unit root test was carried out on the basis of the existing regression model to ensure the validity of the regression results. The unit root smoothness test results show that the P value is 0.0325, less than 0.05, which shows that the data is stable, return and turnover rate is cointegration, the regression results are meaningful.

In this case, the study was further refined to examine the effects of the two portfolios separately:

Table 4: Results of the winner portfolio regression

Variable	Coefficient	Std.Error	t-Statistic	Prob.	R ²	F-Statistic
W ₁	-4.8500	2.6397	-1.8373	0.0768	0.0108	0.0768
WC ₁	14.8467	7.2074	2.0599	0.0488*		

Table 5: Results of the loser portfolio regression

Variable	Coefficient	Std.Error	t-Statistic	Prob.	R ²	F-Statistic
L ₁	-3.1093	1.9649	-1.5824	0.1248	0.0821	0.1248
LC ₁	9.0055	5.3650	1.6786	0.1044		

It is found that the P value of the statistical test of the winners and losers in the portfolio is greater than 0.05, and the P value of the statistical test is higher than 0.05, no significant relationship was found between turnover rate and portfolio return.

medium-term holding portfolio

Table 6: Medium-term holding portfolio regression results

Variable	Coefficient	Std.Error	t-Statistic	Prob.	R ²	F-Statistic
T ₂	-5.2697	2.6755	-1.9696	0.0588	0.1217	0.0588
C ₂	15.959	7.3050	2.1846	0.0374*		

Table7: Medium-term holding portfolio ADF unit root test

	t-Statistic	Prob.
ADF unit root test	-2.5038	0.0142*

From the statistical test p value can be seen, the P value of T2 is about 0.0588, greater than 0.05, at this time the turnover rate and the yield has not shown a significant correlation.

The unit root test results show that P value is 0.0142, less than 0.05, the data is stable, return and turnover rate is cointegration, the regression results are meaningful.

Table 8: Results of the winner portfolio regression

Variable	Coefficient	Std.Error	t-Statistic	Prob.	R ²	F-Statistic
W ₂	-9.5213	3.2614	-2.9194	0.0069**	0.2334	0.0069
WC ₂	28.597	8.9049	3.2113	0.0033**		

Table 9: Results of the loser portfolio regression

Variable	Coefficient	Std.Error	t-Statistic	Prob.	R ²	F-Statistic
L ₂	-4.2510	2.5005	-1.7001	0.1002	0.0936	0.1002
LC ₂	12.635	6.8273	1.8507	0.0748		

It is found that in the winner portfolio, the statistical test p value of turnover rate is about 0.0069, less than 0.01, at the level of 1% , there is a significant correlation between the turnover rate and the yield, the Correlation coefficient is -0.0952, indicating that the turnover rate and the yield is still a negative correlation; The turnover rate has the explanation function to the rate of return, and brings is the negative influence.

For the loser group, the P value is 0.1002, which is still greater than 0.05. There is no significant correlation between the turnover rate and the return of the portfolio.

long-term holding portfolio

Table10: Long-term holding portfolio regression results

Variable	Coefficient	Std.Error	t-Statistic	Prob.	R ²	F-Statistic
T ₃	-7.8550	3.3422	-2.3503	0.0260*	0.1648	0.0260
C ₃	23.605	9.1254	2.5868	0.0152*		

Table 11: Long-term holding portfolio ADF unit root test

	t-Statistic	Prob.
ADF unit root test	-2.623729	0.0106*

From the statistical test p value can be seen that the value of T3 is about 0.0260, less than 0.05, that is, the correlation between turnover and yield is significant at 5% level. Correlation coefficient is -7.8550, indicating that in this case the rate of turnover and yield changes in the opposite direction.

The unit root test results show that P value is 0.0106, less than 0.05, the data is stable, return and turnover is cointegration, the regression results are meaningful.

Table 12: Results of the winner portfolio regression

Variable	Coefficient	Std.Error	t-Statistic	Prob.	R ²	F-Statistic
W ₃	-12.939	3.6435	-3.5511	0.0014**	0.3105	0.0014
WC ₃	38.729	9.9481	3.8931	0.0006***		

Table 13: Results of the loser portfolio regression

Variable	Coefficient	Std.Error	t-Statistic	Prob.	R ²	F-Statistic
L ₃	-5.0842	2.7191	-1.8698	0.0720	0.1110	0.0720
LC ₃	15.125	7.4242	2.0372	0.0512*		

It is found that in the winner portfolio, the statistical test p value of turnover rate is about 0.0014, less than 0.01, at a level of 1%, that is, there is an obvious correlation between the turnover rate and the return rate, and the coefficient is about -12.9387, which shows that the turnover rate and the return rate are still moving in the opposite direction and bring negative effects.

For the loser portfolio, the statistical test p value of turnover rate is 0.072, less than 0.1, which is significant at the level of 1%. There is an obvious correlation between turnover rate and return rate, and the coefficient is about -5.0842, it shows that the turnover rate and the return rate are still moving in the opposite direction, and the liquidity of securities has an explanatory effect on the return of the portfolio and brings about a negative effect.

Data selection and standardization

Table 14: Data collation of empirical results

holding period		1 week	2 weeks	3 weeks
The whole portfolio	Prob.	0.4702	0.0588	0.0260
	Statistical significance	reject	reject	support
	Coefficient	-1.7370	-5.2697	-7.8550
winner portfolio	Prob. of residual test	0.0325	0.0142	0.0106
	Prob.	0.0786	0.0069	0.0014
	Statistical significance	reject	support	support
loser portfolio	Coefficient	-4.8500	-9.5213	-12.9387
	Prob.	0.1248	0.1002	0.0720
	Statistical significance	reject	support	reject
	Coefficient	-3.1093	-4.2510	-5.0842

By comparing the momentum portfolio with different holding periods, we can see that the short holding period of one week and the portfolio with 30 different forming periods do not pass the test, and liquidity has no significant effect on the return of the portfolio, with the holding period extended to 2 weeks, although the overall portfolio did not pass the test, but only from the winner portfolio analysis, securities liquidity has a significant negative impact on the winner portfolio returns. When the holding period increases to the 3rd week, the overall portfolio passes the test, the securities liquidity has a significant negative impact on the investment return, indicating that the higher the liquidity of the securities, the worse the later return, thus

inferring, with the increase of holding period, the negative impact of securities liquidity on momentum investment strategy returns will be more significant.

Therefore, with short holdings within 3 weeks, we support the null hypothesis H0 that Securities liquidity has no effect on momentum strategy return. In long-term holdings of 3 weeks and above, we support the hypothesis H2 that Securities liquidity has a negative correlation with momentum investment strategy return.

The winner portfolio explains more in the overall process, and the impact on returns is clearly greater than that of the loser portfolio. At first, there was no significant relationship between the liquidity and yield of the two portfolios. As the holding period increased, the liquidity of the winner portfolio began to show a more significant impact on the yield than the overall portfolio, while there has always been no significant relationship between securities liquidity and returns in the loser portfolio.

CONCLUSIONS

Results and Discussion

This paper innovatively incorporates liquidity indicators into the momentum investment strategy analysis framework, Selecting the underlying stocks of the CSI 300 Index, measuring the liquidity of securities, using the J-K (winner-loser) portfolio method in behavioral finance to construct a variety of momentum investment portfolios, and measuring the liquidity and portfolio return of the securities portfolio, and explores the impact of security liquidity on momentum portfolio returns through regression analysis, and the concrete conclusion is obtained:

For long-term momentum portfolios, security liquidity will significantly negatively affect portfolio returns. In the short-term and medium-term holding period of 1-2 weeks, the momentum portfolio fails the test, and the liquidity of securities has no significant impact on the return of the momentum portfolio. When the holding period is extended to 3 weeks, the overall portfolio passes the test, momentum portfolio returns are significantly and negatively affected by security liquidity. As the holding period increases, the negative impact of securities liquidity on the returns of momentum investment strategies will become more significant. The higher the liquidity of the momentum investment portfolio, the less ideal the later returns will be. This also reflects that in China's non-strong efficient market, frequent buying and selling may not necessarily lead to better investment returns.

The influence of securities liquidity on winners and losers portfolio is asymmetric. Compared with the loser portfolio, the liquidity of the winner portfolio has a greater impact on the return of the portfolio.

Management Implications

According to the above research results, from the point of view of market managers, it is necessary to improve market transparency, strengthen market liquidity, promote the healthy development of the market, market participants in good faith transactions to provide protection. The improvement of the operating quality of the securities market will be reflected well in the investment returns, which is naturally conducive to attracting more investors to actively participate in the securities investment and promoting the high-quality development of the entire financial market. Helping the high-quality development of e-commerce from financial services.

From the perspective of securities investors, on the one hand, when the momentum investment strategy is adopted in our country's securities market, in order to ensure the effectiveness of the strategy and obtain the expected excess return, the securities liquidity index must be incorporated into the momentum investment strategy optimization framework. If the holding period is longer, a momentum portfolio should be constructed with less liquid securities. On the other hand, investors cannot blindly buy and sell according to liquidity. If investors pay too much attention to liquidity indicators, follow the wind direction and blindly ignore the actual investment value, such irrational behavior will exacerbate market volatility. The effectiveness of momentum investing strategies will inevitably suffer as well.

In a word, the research results of this paper not only fill the deficiency of the current theoretical research on the impact of stock liquidity on momentum investment strategy returns, but also provide empirical support for the further exploration of the relationship between the two, it also provides an innovative reference index for stock investors to optimize their momentum investment strategies and speeds up the process of exploring the effectiveness of momentum investment strategies. The above theoretical value and practical significance will directly promote the high-quality operation of the stock market and provide better financial service support for the development of e-commerce.

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APPENDIX A: Results of standardization of sample data

Table 1: Return and turnover of each portfolio

Formation period Holding period		1week	2weeks	3weeks	Turnover (%)
1week	Winner	0.0303	0.0754	0.0802	2.12
	Loser	0.0214	0.0374	0.0136	
	Winner—Loser	0.0089	0.0380	0.0666	
2weeks	Winner	0.0373	0.0635	0.0635	2.54
	Loser	0.0060	-0.0292	-0.0292	
	Winner—Loser	0.0314	0.0927	0.0927	
3weeks	Winner	0.0407	0.0407	0.0935	2.69
	Loser	-0.0471	-0.0471	-0.0762	
	Winner—Loser	0.0878	0.0878	0.1697	
4weeks	Winner	0.0640	0.0882	0.1632	2.87
	Loser	-0.0351	0.0053	0.0331	
	Winner—Loser	0.0991	0.0829	0.1301	
5weeks	Winner	0.0312	0.0850	0.0030	2.72
	Loser	0.0505	0.0857	0.0232	
	Winner—Loser	-0.01933	-0.00076	-0.02019	
6weeks	Winner	0.0541	-0.0413	-0.0308	3.00
	Loser	0.045563	-0.02121	0.023987	
	Winner—Loser	0.008539	-0.02013	-0.05482	
7weeks	Winner	-0.09066	-0.07873	-0.12936	3.06
	Loser	-0.05254	-0.00254	-0.04523	
	Winner—Loser	-0.03812	-0.07619	-0.08413	
8weeks	Winner	0.02932	0.020021	-0.05244	2.78
	Loser	0.060348	0.008632	-0.06299	
	Winner—Loser	-0.03103	0.011389	0.010552	
9 weeks	Winner	-0.02439	-0.09496	-0.13471	3.07
	Loser	-0.04233	-0.10323	-0.09547	
	Winner—Loser	0.017935	0.008277	-0.03924	
10 weeks	Winner	-0.06461	-0.10999	-0.10598	3.21
	Loser	-0.07313	-0.05874	-0.0629	
	Winner—Loser	0.008525	-0.05125	-0.04308	
11 weeks	Winner	-0.0445	-0.0445	-0.0302	3.23
	Loser	0.0220	0.0243	0.0397	

	Winner—Loser	-0.0664	-0.0688	-0.0699	
12 weeks	Winner	0.0033	0.0274	0.0513	3.38
	Loser	0.0092	0.0233	0.0377	
	Winner—Loser	-0.0058	0.0041	0.0136	
13 weeks	Winner	0.0245	0.0484	0.0526	2.95
	Loser	0.0205	0.0293	0.0112	
	Winner—Loser	0.0040	0.0191	0.0414	
14 weeks	Winner	0.0138	0.0259	0.0382	2.65
	Loser	0.0088	-0.0099	0.0369	
	Winner—Loser	0.0050	0.0358	0.0013	
15 weeks	Winner	0.0027	0.0210	0.0436	2.51
	Loser	-0.0176	0.0258	0.0378	
	Winner—Loser	0.0203	-0.0049	0.0058	
16 weeks	Winner	0.0112	0.0420	0.0404	2.50
	Loser	0.0483	0.0693	0.0424	
	Winner—Loser	-0.0371	-0.0273	-0.0020	
17 weeks	Winner	0.0287	0.0594	0.0442	3.07
	Loser	0.0250	-0.0028	-0.0256	
	Winner—Loser	0.0037	0.062	0.0697	
18 weeks	Winner	0.0259	0.0006	0.0783	2.51
	Loser	-0.0203	-0.0414	-0.0311	
	Winner—Loser	0.0463	0.0419	0.1094	
19 weeks	Winner	-0.0365	0.0273	0.0801	2.42
	Loser	-0.0184	-0.0074	0.0334	
	Winner—Loser	-0.0181	0.0347	0.0467	
20 weeks	Winner	0.0558	0.0685	0.0747	2.44
	Loser	0.0085	0.0437	0.0399	
	Winner—Loser	0.0475	0.0248	0.0348	
21 weeks	Winner	0.0028	0.0033	0.0429	2.28
	Loser	0.0407	0.0430	0.0590	
	Winner—Loser	-0.0379	-0.0397	-0.0161	
22 weeks	Winner	0.0114	0.0517	0.0645	2.15
	Loser	0.0007	0.0209	0.0154	
	Winner—Loser	0.0107	0.0308	0.0491	
23 weeks	Winner	0.0355	0.0506	0.0741	2.20
	Loser	0.0198	0.0167	0.0947	

	Winner—Loser	0.0156	0.0339	-0.0206	
24 weeks	Winner	0.0098	0.0440	0.1992	2.43
	Loser	-0.0099	0.0601	0.1292	
	Winner—Loser	0.0196	-0.0161	0.0700	
25 weeks	Winner	0.0361	0.1921	0.1272	2.55
	Loser	0.0705	0.1394	0.0850	
	Winner—Loser	-0.0343	0.0527	0.0422	
26 weeks	Winner	0.1747	0.1009	0.1000	2.44
	Loser	0.0560	0.0098	0.0146	
	Winner—Loser	0.1187	0.0912	0.0854	
27 weeks	Winner	-0.0652	-0.0660	0.0167	2.91
	Loser	-0.0448	-0.0484	-0.0371	
	Winner—Loser	-0.0204	-0.0176	0.0539	
28 weeks	Winner	0.0032	0.0893	0.0910	2.97
	Loser	-0.0071	0.0034	0.0089	
	Winner—Loser	0.0103	0.0859	0.0821	
29 weeks	Winner	0.0920	0.0999	0.0298	2.98
	Loser	0.0134	0.0255	0.0441	
	Winner—Loser	0.0786	0.0744	-0.0143	
30 weeks	Winner	0.0184	-0.0517	-0.0695	3.09
	Loser	0.0148	0.0347	0.0458	
	Winner—Loser	0.0036	-0.0864	-0.1154	

Research on the influence of art perception on consumers' purchase intention in online shopping environment

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ABSTRACT

There are more and more cases of cooperation between products and art. The combination of art and product is an important global commercial trend. Hagtvedt and Patrick put forward the theory of art infusion effect, the combination of art and products will have a positive impact on consumer evaluation. This study extends the theory of art infusion effect to the online shopping environment to explore whether the art infusion effect exists when consumers shop online. New models are also proposed to further study the outcome variables and moderating variables of art infusion effect. It is found that the art infusion effect still exists in the online shopping environment, that is, the art perception of the product positively affects the product evaluation. Moreover, the art infusion effect can further improve consumers' purchase intention. Finally, openness to art plays a moderating role in this process.

Keywords: Art infusion effect, Art perception, Online shopping, Purchase intention.

INTRODUCTION

The development of the Internet has brought the prosperity of online shopping. Especially since the epidemic, people's demand for online shopping has increased greatly. In order to meet this demand, the number of online retailers has also increased sharply. Competition among retailers is fierce. However, due to various factors such as trust (Stouthuysen et al., 2018) and perceived risk (Pelaez et al., 2019), it is increasingly difficult for consumers to generate online purchase intention (Liang et al., 2020; Dabrynin & Zhang, 2019). According to the characteristics of online shopping, studies have explored its influence on improving consumers' online shopping intention from the aspects of online shopping experience, online convenience and social ties (Saha et al., 2022; Liang et al., 2020). Some studies have also analyzed the role of traditional trust factors and their antecedents on online shopping intentions (Qalati et al., 2021). In short, it is still very important to study how to improve consumers' online purchase intention in the post-pandemic era.

To increase the appeal of their products, the luxury world has collaborated with the art world. For example, famous pop artist Andy Warhol designed bottles and advertising posters for Chanel No. 5 perfume, and Louis Vuitton collaborated with pop artist Jeff Koons to print famous paintings on LV bags. In fact, with more and more cases of the combination of art and products, the brand types and art types of cooperation are also expanding. For example, the Chinese skin care brand BIOHYALUX cooperated with the Palace Museum to launch lipstick and facial mask products with the elements of classic artifacts. Hagtvedt and Patrick (2008) first put forward the theory of art infusion effect, that is, the integration of art, products and brands can improve the sense of luxury of brands and thereby improve the brand evaluation of consumers. And the effect of art infusion is based on the premise that consumers can perceive "art". Later, studies on the effect of art infusion have also confirmed the existence of art infusion effect in various consumption environments such as advertising scenes and museum scenes (Huettl & Gierl, 2012; Lee et al., 2015; Logkizidou et al., 2019).

Among the 14 paths for further research in the field of art infusion effect proposed by Baumgarth (2018), a major research path based on the perspective of consumers is to expand the types of art, such as art from different cultural backgrounds and styles. Huttl-maack (2018) also proposed that the research should be extended to the investigation of different art types in the future, which may have an important impact on consumers' perception of products or brands. However, previous studies lack attention to the sales scenario. Studies on the effect of art infusion are usually placed in the offline sales scenario (Naletelich & Paswan, 2018; Logkizidou et al., 2019; Cuny et al., 2020). Online sales channels and offline sales channels show fundamental differences, thus online provides consumers with completely different experience (Xu et al., 2022). With the advent of the epidemic, people's demand and willingness for online shopping continue to increase (Repko, 2020), and the transformation of consumption paradigm from offline to online is accelerating (Moon et al., 2021). It is necessary to consider the following questions: Does the art infusion effect exist in the online consumption environment? If so, does it play a role in the purchase intention of consumers? What are the boundary conditions of the process?

In order to answer the above questions, 287 consumers with online shopping experience were surveyed. The results show that art infusion effect exists in online shopping environment. Product evaluation plays a mediating role in the influence of art perception on consumers' purchase intention. The consumer's openness to art plays a moderating role in this process. The

remainder of this article is organized as follows. The next section reviews the literature and develops a research framework. Then introduce the survey method in detail. The following is the analysis of survey data results. Finally, this paper is summarized and discussed.

LITERATURE REVIEW

The concept of "art infusion effect" was proposed by Hagtvedt and Patrick (2008), which refers to the integration of visual art into advertising and product design, which can improve consumers' evaluation by improving the brand's sense of luxury. The art infusion effect arises because art is often closely associated with high culture, sophistication and luxury (Hoffman, 2002). Therefore, the existence of artworks can make the temperament of art "spill over", add cultural connotation to commodities, and make related objects look more luxurious (Hagtvedt & Patrick, 2008). Business organizations can use art to create intangible value and integrate it into products (Schiuma, 2011). For example, art can be integrated into new product development and product design in the marketing process to create added value of products (Troilo, 2015).

Since then, the research on the effect of art infusion has gradually emerged, and scholars have carried out various studies especially around the types of art. The research object of art infusion effect is based on Western classical art (Hagtvedt & Patrick, 2008), and then gradually expanded to African art (Van Niekerk & Conradie, 2016) and urban art (Baumgarth & Jennifer, 2018) and experiential art (Cuny et al., 2020). Some studies have also discussed the model of art infusion effect. Hagtvedt and Patrick (2008) first proposed that the art infusion effect is mediated by luxury perception, and later confirmed through experiments that luxury perception, lifestyle perception and fit all mediate the art infusion effect (Baumgarth & Jennifer, 2018). The emotion-based art infusion effect model found that art enhances the perceived value of products (namely, art infusion effect) by arousing consumers' emotion (namely, brand influence), and product type moderates the effect of art infusion (Estes et al., 2018). The explanation of boundary conditions and driving factors of art infusion effect is further increased. Individual artistic interest is found to play a moderating role and perceived value for money is the mediating variable driving the effect of art infusion under certain conditions (HuttL-Maack, 2018).

However, the existing related studies usually take offline sales scenes as the research background, and lack of research on the existence and characteristics of art infusion effect in online consumption environment. Naletelich and Paswan (2017) investigated the influence of different art types in non-luxury retail on consumer behavior by taking offline optical-shop as the experimental scene. Logkizidou et al. (2019) compared the museum display form of products with the non-museum display form. Found that it was better to display products in museum form. Cuny et al. (2020) explored the effect of art intervention in service environment on brands. With the post-epidemic era, online shopping continues to grow in popularity. As an important way for people to shop, online shopping should become the focus of research. Therefore, this paper studies the effect of art infusion in online consumption environment, mainly investigates whether the art infusion effect exists in online shopping environment. If so, how this effect affects consumers' purchase intention and what are the boundary conditions of this process?

Art Perception and Product Evaluation

"Art infusion effect" is interpreted to mean that when visual art is integrated into advertising and product design, consumers' evaluation can be improved by improving the brand's sense of luxury (Hagtvedt & Patrick, 2008). And this positive effect does not depend on the specific artistic content. No matter how consumers evaluate the artistic content itself, as long as the artwork is considered as art by consumers, art can improve product evaluation. In other words, consumers' art perception of products can improve product evaluation. Further research shows that artistic product design can not only improve product evaluation, but also make up for the poor function of the product (Hagtvedt & Patrick, 2014). However, in the online consumption environment, consumers are more likely to perceive products through visual cues (for example, to view the texture of products through images) (Daugherty et al., 2008), and the visual effect of products is more important in the online shopping environment.

According to cue utilization theory, consumers judge product quality based on a series of cues related to products (Cox, 1967). Consumers often use internal cues (e.g., product features) and external cues (e.g., product packaging) to form product evaluations. Compared with complex and costly internal cues, consumers are more likely to use simple and low-cost external cues (Woodside, 2012). As the external clue of the product, the packaging of art products can be easily identified and obtained by consumers. The perception of art obtained by consumers from the packaging of art further affects the evaluation of the product by consumers. Therefore, we propose the following hypothesis:

H1: Art perception has a positive impact on product evaluation.

Product Evaluation and Purchase Intention

S-O-R theory holds that external stimuli can affect individual perception and attitude through individual mental activities and internal cognitive processes. Individuals produce final behavioral responses based on perception and attitude (Namkung & Jang, 2010). Studies have found that the shape of the product booth, as an external cue to stimulate consumers, can affect consumers' evaluation of the product, and product evaluation has an impact on consumers' purchase intention (Cavazza & Gabrielli, 2015). It is also possible to obtain consumers' perception of artworks through art processing in the retail environment. Artist information, as an external stimulus, can promote the influence on consumers' behavioral intentions by mediating their attitudes towards artworks and artists (Oh et al., 2018). Similarly, in this study, the artistic packaging of products, as an

external stimulus, enables individual consumers to obtain art perception, and the cognitive process affects individual consumers' product evaluation. Product evaluation is consumers' subjective perception and attitude towards product attributes after processing product information. Individual consumers generate behavioral reactions of purchase intention based on product evaluation.

The theory of planned action is an extension of the theory of rational action. The theory of rational action predicts and explains individual behaviors based on the hypothesis that the occurrence of behaviors is based on the control of individual willpower. However, in reality, many external factors such as time and money will affect individual willpower control. Especially in online shopping, factors related to online store design and promotional stimulation greatly influence consumers' online impulse buying behavior in the whole decision-making process of consumers (Lo et al., 2016). Therefore, this paper is suitable to use the theory of planned behavior in the context of online shopping. In the theory of planned behavior, attitude positively affects behavioral intention (Ajzen, 1985). As an external variable, artistic packaging affects consumers' product evaluation. Product evaluation comes from consumers' evaluation of the results of purchasing products, which is consumers' subjective perception and attitude. Product evaluation affects consumers' purchase intention.

In the study of online clothing purchasing, the presentation of linguistic information influences tactile images, which in turn influences behavioral responses (purchase intention) through the cognitive evaluation of customers (perceived product quality)(Silva et al., 2021). The emerging 3D VR technology affects the decision-making process of online purchase. Through three interface features: interactivity, visual-spatial cues and graphic quality, it improves the interest and information evaluation of customers' purchase, and then affects the subsequent purchase intention (Kang et al., 2020). In the online shopping environment, if consumers can process product information smoothly, they will evaluate products more positively (Mosteller et al., 2014), thus increasing their choice and preference for products (Chan & Northey, 2021). Therefore, we propose the following hypothesis:

H2: Product evaluation has a positive impact on purchase intention.

Artistically Open

The characteristics of consumers are an important factor affecting the purchase intention of products, especially the artistic background in this study is very prominent, and the attitude of consumers towards art may have a certain impact on the purchase process of consumers. Openness to experience reflects cognitive engagement with perception, fantasy, aesthetics and emotion (Kaufman et al., 2016). Openness to experience consists of five aspects - artistically, intellectually, imaginatively, politically, and emotionally open (Naletelich & Paswan, 2018). Openness to experience is not only related to artistic judgment and artistic interest (Afhami & Mohammadi-Zarghan, 2018), but also related to creative achievement of art (Kaufman, 2013; Kaufman et al., 2016).

Since openness to art is more closely related to this study, this study focuses on the dimension of openness to art. As a dimension of openness to experience (McCrae & John, 1992), openness to art is defined as the curiosity and cognitive ability to explore interesting ideas, concepts and creations in aesthetics and art (John & Srivastava, 1999). Openness to art has also been found to be directly related to artistic experience (preference) and participation in artistic activities (Furnham & Chamorro-Premuzic, 2004; Chamorro-Premuzic et al., 2009 ; Atari et al., 2020).

As for the influence of art in offline retail, studies have shown that people who are open to art may be positively influenced by art retail stores (Furnham & Walker, 2001), improve their evaluation of products, and thus enhance their purchase intention. However, people with low openness to art will not be positively affected by art retail stores, and the art perception of products has no significant impact on their purchase intention. Some studies have also found that when consumers' art knowledge and openness to experience are low, the impact of attitude toward art on behavioral intention will be amplified (Oh et al., 2018). Therefore, we make the following assumptions:

H3: Artistically open can moderate the influence of art perception on purchase intention.

Therefore, the theoretical model of this research is shown in Figure 1.

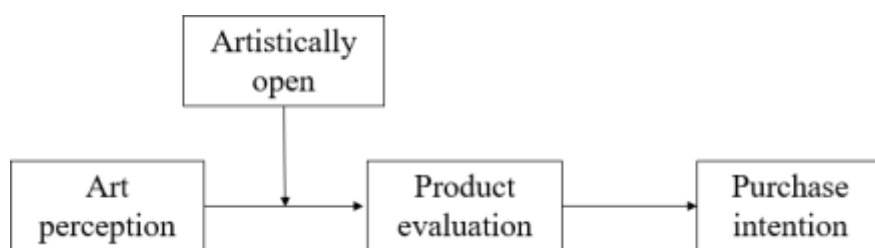


Figure 1: Conceptual research model

METHODOLOGY

Through investigation and research, this study explores the influence of art perception of products on consumers' purchase intention in online shopping. Among them, consumer's product evaluation plays a mediating role on consumer's purchase intention, and artistically open plays a moderating role. The online questionnaire designed for the study consisted of two parts. The first part is about the demographic variables of the respondents, including gender, age, education background and online shopping frequency. The second part uses 12 measurement items to investigate the respondents' perception of art, openness to art, product evaluation and purchase intention. All items were measured on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The respondents were asked to complete a self-administered questionnaire. Respondents recalled whether they had seen products with artistic packaging when shopping online and answered the questionnaire based on their experience. Published the link of the questionnaire on the open online survey platform, and promoted it through wechat, QQ, Weibo and other social media. A total of 301 responses were received, and 287 valid responses were obtained by excluding the unqualified data (samples that answered no to the question "I have encountered products with artistic packaging in my online shopping experience").

Table 1 shows the characteristics of the respondents. 43.9% of the respondents were male and 56.1% were female. About half of the respondents were between 20 and 30 years old, and almost 80 percent were between 20 and 40 years old. 65.9% of the respondents had a bachelor's degree. In the past month, 35.9% of respondents shopped online "1-5 times" and 46.3% shopped online "6-10 times". This sample distribution is similar to other related studies. The majority of online shopping groups are young people of Generation Y (Lissitsa & Kol, 2016). Most of them have undergraduate education background, and the number of monthly shopping is concentrated between 4-11 times (Xiong, 2022; Dang et al., 2020). Therefore, the sample of this study is representative.

Table 1: Characteristics of Respondents (N=287)

	Categories	Frequency	%
Gender	Male	126	43.9
	Female	161	56.1
Age	Under 20	37	12.9
	20-30	145	50.5
	31-40	86	30.0
	Above 40	19	6.6
Education	Under Bachelor's degree	70	24.4
	Bachelor's degree	189	65.9
	Master's degree	17	5.9
	Doctor's degree	11	3.8
Frequency of online shopping in the past month	1-5	103	35.9
	6-10	133	46.3
	above 10	46	16.0
	0	5	1.7

Cronbach's Alpha was used for reliability analysis. The Cronbach Alpha value of the questionnaire was high, and the Cronbach Alpha value of each construct was more than 0.7. This indicates that the measurement items are reliable. We give Cronbach's alpha in Table 2. Hagtvedt and Patrick (2008) were used to measure the construction of the variables of art perception and product evaluation. Cronbach's alpha of product evaluation was 0.945. Naletelich and Paswan (2018) was used to measure the openness to art. The Cronbach's alpha of artistically open was 0.946. The four items of Ma et al. (2021) were used to measure the purchase intention of products, and the Cronbach's alpha of purchase intention was 0.933.

Table 2: Constructs, Items, Cronbach 's Alpha and Sources

Constructs	Items	Cronbach 's Alpha	Source
Artistically Open	I like art.	0.946	Yang, Kim and Yoo (2013)
	I like drawings.		
	I enjoy going to art museums.		
Art Perception	I think this product is art.	0.945	Hagtvedt and Patrick (2008)
	.		
Product Evaluation	I think this product is positive.	0.945	Russell, Stern and Stern (2006)
	I think this product is good.		
	I think this product is pleasant.		
	I like this product very much.		
Purchase Intention	It is possible that I would buy this product.	0.933	Evans <i>et al.</i> (2017)
	If I am in need, I would buy this (product).		
	I would consider buying this product.		
	I will purchase (brand) the next time I need a (product).		

DATA ANALYSIS AND RESULTS

Common Method Bias

Because all constructs were measured subjectively in relation to the same sources at the same time, this study carried on an additional step to check a potential common method bias. We employed the Harman single-factor test and an exploratory factor analysis using SPSS 22.0. No single factor appeared in the statistical results, because the variance of the first factor was 35.43%, which was lower than the 50% threshold suggested by Harman (1976). Therefore, common method bias was not a serious concern in this study.

Regression Analysis and Mediation Analysis

Firstly, the average value of product evaluation question and purchase intention question was taken as the value of product evaluation and purchase intention of the subjects. The regression analysis was conducted three times. The results showed that the total effect of art perception on purchase intention was significant ($\beta = 0.94$, $t=47.29$, $p < 0.01$), and art perception had a positive effect on purchase intention. The effect of art perception on product evaluation was significant ($\beta = 0.34$, $t=6.03$, $p < 0.01$), and art perception had a positive effect on product evaluation, which proved H1. After controlling art perception, product evaluation had a significant predictive effect on purchase intention ($\beta = 0.39$, $t=7.04$, $p < 0.01$), and product evaluation had a positive effect on purchase intention. H2 is confirmed.

The mediation effect was further tested according to the Bootstrap method proposed by Hayes. The PROCESS plug-in in SPSS 22.0 was used to select Model 4 by bootstrap procedure, and 5 000 random samples were carried out under 95% confidence interval. The results show that consumers' art perception of products can affect consumers' purchase intention by influencing product evaluation. The confidence interval (LLCI=0.008, ULCI=0.051) does not include 0, that is, the mediating effect of product evaluation is significant, and the effect value is 0.024.

Therefore, the study firstly proves H1 and H2, art perception has a positive impact on product evaluation and product evaluation has a significant impact on purchase intention. Furthermore, based on the proof of H1 and H2, the mediating effect of product evaluation is found, that is, art perception further influences consumers' purchase intention by influencing product evaluation, as shown in Table 3.

Table 3: The Mediating Role of Product Evaluation

	Effect	SE	t	p	LLCL	ULCI
Direct Effect	0.839	0.019	44.275	<0.01	0.801	0.876
Indirect Effect	0.024	0.010	—	—	0.008	0.051

Analysis of Regulation Effect

Next, ANOVA was used to test the moderating effect of artistically open on purchase intention. The results showed that: Art perception has a significant impact on purchase intention ($F(1,285)= 256.89$, $p < 0.01$), and artistically open has a significant impact on purchase intention ($F(1,285)=2.814$, $p < 0.01$). The interaction between art perception and artistically open can affect consumers' purchase intention. That is, the interaction term of the two has a significant impact on purchase intention ($F(1,285)=2.809$, $p < 0.01$). Independent sample t-test was further conducted, and the results showed that compared with consumers with low artistic openness, for consumers with high artistic openness, the art perception of products is more conducive to stimulate consumers' purchase intention ($M_{High}=5.67$, $SD=0.93$ vs. $M_{Low}=4.44$, $SD=1.82$, $t(285)=7.42$, $p < 0.01$).

The mediation effect was further tested according to the Bootstrap method proposed by Hayes. The results show that artistically open moderates the mediating effect of product evaluation. Under the condition of low artistic openness, the mediating effect of product evaluation is significant (LLCI=0.005, ULCI=0.074, interval does not include 0). Under the condition of high artistic openness, the mediating effect of product evaluation is not significant (LLCI=-0.004, ULCI=0.009, the interval includes 0). The research model diagram in FIG. 1 is validated.

The study proves that H3, namely, the influence of art perception on purchase intention is moderated by artistically open. Specifically, in the case of high artistic openness, art perception has a more positive impact on consumers' purchase intention; In the case of low artistic openness, art perception influences the purchase intention by influencing the product evaluation, but has no obvious positive effect on the purchase intention of consumers. In addition, the data results further verify the mediating effect of product evaluation in a moderating way.

CONCLUSION AND DISCUSSION

Conclusion

Taking art infusion effect as the theoretical basis and popular online shopping as the research background, this study proposes and tests a conceptual model, which assumes that consumers' art perception of products in online shopping is conducive to improving consumers' evaluation of products and thus influencing consumers' purchase intention. The consumer's trait, openness to art, plays a moderating role in this process. This study reveals the positive role of art in online shopping product marketing, and provides a reference for brand policy to carry out precision marketing to consumers..

Our results provide support for the hypothetical research model and hypothesis. It is found that when shopping online, consumers' art perception of products with artistic packaging affects product evaluation, and product evaluation further affects consumers' purchase intention. Previous studies have generally focused on the influence of consumers' art perception on product attitude and its mediators (Hagtvedt & Patrick, 2008; Baumgarth & Jennifer, 2018). This study extends the previous results by extending the influence of art infusion effect to consumers' purchase intention, and finds that product evaluation plays a mediating role in the influence of art perception on purchase intention.

It is also found that artistically open plays a moderating role in the influence of art perception on purchase intention. As a key trait of consumers in art marketing, artistically open has a certain influence in art marketing. This study finds that, compared with consumers with low artistic openness, for consumers with high artistic openness, art perception has a more positive effect on purchase intention.

Theoretical Implications

This study further verified and extended the theory of art infusion effect, and explored the outcome variables and moderating variables of art infusion effect. This study extends the effect of art infusion backward, investigates whether art perception has an impact on consumers' purchase intention, further extends the effect of art perception from consumer attitude to consumer behavior, and deepens the research on the effect of art infusion. In addition, this study also discusses the role of the moderating variable artistically open, which plays a moderating role in the process of art perception influencing consumers' purchase intention.

This study explores the effect of art infusion in the context of online shopping. Most of the previous studies discussed the effect of art infusion in the offline retail environment. However, as consumers are increasingly inclined to shop online, it is worth exploring whether art marketing in the online shopping environment has the same power. This paper conducts research in the context of online shopping and finds that the art infusion effect still exists in online shopping. When consumers see products with art packaging in online shopping, the art perception formed by consumers influences the product evaluation and thus the purchase intention.

Management Implications

When brands, stores and other sellers sell products through online platforms or online channels, they should focus on using artistic elements in marketing to enhance the attractiveness of their products. Research has found that art perception has a significant impact on consumers' attitudes toward products and purchase intentions in the online shopping environment. Sellers can incorporate artistic elements into the online marketing of their products so that consumers can gain art perceptions about their products and then positively influence their product evaluations and purchase intentions. Artistic elements can be used in a variety of ways, including artistic packaging of product images, artistic design of sales pages, and artistic promotional advertisements on the Internet, to improve consumers' art perceptions of products and thus motivate them to purchase.

Online shopping sellers should also consider carrying out precision marketing to improve the art perception of products or brands among consumers with high artistic openness. For consumers with high artistic openness, art perception has a more positive impact on purchase intentions, so brands should focus on creating an artistic atmosphere for their products in all aspects, creating additional cultural and artistic values for their products, and increasing the attractiveness of their products to these consumer groups. For consumers with low artistic openness, art perception affects purchase intention by influencing product evaluation. Brands can appropriately package their products artistically, but should emphasize the quality of the products themselves to increase the purchase intention of these people.

Limitations and Future Research

However, this study still has some limitations. First of all, this study is an overall investigation of the influence of art on consumers' purchase intention in online shopping environment, without specifically distinguishing the possible differences between different art types in this process. The research on art types on consumers' purchase intention can be further refined in the future. Secondly, the forms of art presentation become more diversified with the progress of science and technology, such as the VR display technology emerging in recent years. This study takes the art packaging of products as a way for consumers to perceive art. In the future, we can further study the influence of different ways of combining art and products on consumers' purchase intention. Finally, this article unified focus on the art infusion effect of the online consumption environment, but with the use of mobile devices and mobile communication network is increasing (Cao et al., 2015), mobile commerce gradually strong. It is different from Internet-based e-commerce, and the different characteristics of the two online channels can be further explored in the future.

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Research on the influencing factors of demand for elderly care services based on data of elderly care service information system

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ABSTRACT

Elderly care has emerged as a pressing concern for society as a whole in the setting of global aging. The elderly care service information system can play an important role in the study of elderly care issues. This study uses Anderson's Behavioral Model and Maslow's Hierarchy of Needs Theory as the analytical framework and guide, applies multiple logistic regression analysis, and is based on the data from the elderly care service information system to study the factors influencing the demand for elderly care services and the interaction between the influencing factors in terms of predisposing factors, enabling factors and need factors. Compared with physiological demand, age, living status and self-care ability have a significant impact on physiological demand. Environmental demands are significantly influenced by age, educational level, living status, child support situation and self-care ability, while gender does not have a significant effect on either type of demand. The main effects model fits better with the addition of the interaction term. There is a significant interaction effect between the three types of factors. Finally, this study proposes suggestions from two perspectives: the supply of elderly care services and the construction of the elderly care service information system.

Keywords: Elderly care service information system, demand for elderly care services, Anderson's Behavioral Model, Maslow's Hierarchy of Needs Theory, logistic regression.

INTRODUCTION

According to the UN definition of an aging country (region), China officially became a country with an aging population back in 2000. Today, China has a large and aging population as well as a similar situation in many developed Western countries. Against this backdrop, the issue of old age has become a social issue that has received a high and widespread level of attention from the government and academia. More and more scholars are beginning to study the issue of elderly care, including the demand for elderly care services. At present, the supply of elderly care services still lags behind the demand for elderly care services (Heng & Zhi, 2020), and presents problems such as insufficient total number of services, insufficient professional service personnel, single service content and lack of effective integration of resources (Baumbusch et al., 2019).

With the advantages of effectively integrating fragmented service resources and providing accurate and personalized services, the elderly care service information system plays an important role in solving the imbalance between the supply and demand of elderly care services, and meeting the needs of the elderly for elderly care services in all aspects. However, most elderly care services have not yet been able to meet the specific needs of the elderly in a point-to-point manner, which means that the elderly care services are not precise and personalized. Some of the elderly's needs are not met through the information system, and the services provided by the information system may not be satisfactory to the elderly.

The main target group of elderly care services information systems is the elderly. Only by grasping the characteristics and needs of the elderly and the links between the two can we provide better quality and more appropriate services to them to maximize the effectiveness of the elderly care services information system. Therefore, this paper explores how each influencing factor affects the demand for elderly care services in an elderly group, starting from the personal characteristics and needs of the elderly and using the service data in an elderly care services information system. It also investigates the interaction effects on this basis in order to promote the development of elderly services and to solve the important livelihood issue of elderly care more efficiently.

This study uses the Anderson's Behavioral Model and Maslow's Hierarchy of Needs as the analytical framework and guidance, and adopts a multiple logistic regression analysis. Based on the data from the elderly care information system, the study investigates the factors influencing the demand for elderly care services and the interaction between the influencing factors in terms of predisposing factors, enabling factors and need factors. Moreover, this study proposes countermeasures based on the research results, aiming to help the relevant entities in the field of elderly care to improve their elderly care services, and to guide the construction and improvement of the elderly care service information system.

This study analyses the current needs of the elderly in elderly care services to further explore the factors that influence the needs of the elderly in elderly care services and the interaction between each factor. The findings of the study can provide

references for the construction of elderly care service information systems. At the same time, this study directly analyses and mines the service data in the elderly care information system, and adds interaction terms to improve the model, to provide a further and objective reflection of the current situation of demand.

LITERATURE REVIEW

Research on the Demand for Elderly Care Services

Exploration and research into the demands of the elderly care services continue, although research began early and a great deal of experience has been accumulated in some countries. Lee et al. researched the differences in the demands of vulnerable groups and their caregivers and health care providers for IoT services in the home, and the findings pointed out that the elderly and people with disabilities were most in need of services in both emergency management and safety and security (Lee et al., 2020). Mazurek et al. found that the companionship of others and psychological distress are needed that most older people have but are not well satisfied. The needs that are satisfied include accommodation, daily household skills, and food. In addition, older people with higher levels of psychological distress have poorer cognitive functioning and more unsatisfied needs (Mazurek et al., 2015). Naruse et al. found that older people have a greater need for domestic care in the area of daily living (Naruse et al., 2011). Machizawa et al. pointed out that older people's physical demand for independence, cultural participation, social connection, self-fulfilment and maintenance of self-esteem have an impact on their preferences for elderly care services (Machizawa & Lau, 2010).

Research on the Influencing Factors of Demand for Elderly Care Services

Scholars have conducted numerous studies on the factors influencing the demand for elderly care services from a micro perspective, exploring in depth the effects of various factors, including age, gender, ethnicity, economic level, self-care ability, health, marital status, number of children, residential status, and literacy. Travers et al. found that factors such as race and ethnicity affect the use of care services by older people (Travers et al., 2020). Stein et al. found that older people's unmet care needs were significantly associated with their having depression, and also with gender, the residential care facility they were in, relatives' ability to care and health status (Stein et al., 2016). Eric De Jonge et al. pointed out the important role of economic factors in the demand for elderly care services, with older people preferring to use services that cost less (Eric De Jonge et al., 2014). Kempen et al. found that gender, whether or not they lived alone and income level also play a role in older people's choice of home care (Kempen & Suurmeijer, 1991).

In addition, some studies focus on the factors that influence the demand for different types of elderly care services. Barnay et al. researched the specific impact of personal characteristics on the physical demand of older persons (Barnay & Juin, 2016). Meinow et al. pointed out that older people with cognitive impairment have a greater need for home care services (Meinow et al., 2005).

Research on Elderly Care Services Information System

In the area of information systems for elderly care services, there has been a preponderance of research on system construction, usually practice-oriented applied research. Cho proposed to use big data from NHIS to carry out work related to the care needs assessment of older people directly in the community care system (CC system), both to improve the accuracy of the assessment results and to respond to the need for contactless work in crisis situations such as the new crown epidemic (Cho, 2020). Menghi et al. have designed an older person-centred product service platform that tailors services to older people and optimises local health resources, aiming to improve independence and quality of life for older people (Menghi et al., 2019). Willard et al. designed an online community care platform (OCC-platform) with care, health and communication functions, focusing on the needs of frail older people for an elderly care platform, aiming to support and serve frail older people by encouraging self-care and providing reliable information, products and services (Willard et al., 2018).

Review

Overall, it can be seen that some research has been carried out in the literature on both the demand for elderly care services and the elderly care services information systems. But there are still some shortcomings. Firstly, for studies on the factors influencing the demand for elderly care services, the sample data is mostly obtained through questionnaires or interviews, and the findings are easily affected by the professionalism and subjectivity of the investigators as well as the perception of the respondents. Therefore, this study uses service data from the information system of elderly care services for the study, which is not only an objective data sample but also a sufficient amount of data. Secondly, research on information systems for elderly care services has mostly focused on the systems themselves, ignoring the elderly population as users of the systems. So this study takes a new research perspective. Thirdly, although there have been many studies exploring the factors that influence the demand for elderly care services. They mostly stay on the main effects of the influencing factors, and the interaction effects generated by the influencing factors are also important. So this paper improves the model from that perspective to study the interaction between the influencing factors.

Based on the background of the previous study and the analysis and combing of the current state of research, this study raises and attempts to answer the following four questions:

- (1) What are the characteristics of the demands for elderly care services?
- (2) What factors can affect the demand for elderly care services?
- (3) What is the specific impact of each factor on the demand for elderly care services?

(4) How does the inclusion of interaction terms for different categories of influencing factors affect the model?

METHODS

Study Model

Andersen's Behavioral Model was developed in 1968 by the US medical sociologist and health services researcher Ronald M. Andersen. The original model pointed out that three dimensions of predisposing factors, enabling factors and need factors can affect an individual's health service utilization behavior. Among them, predisposing factors refer to the tendency of individuals to choose health services due to the influence of their own social and cultural characteristics; enabling factors refer to the individual's ability to obtain service resources; need factors refer to health service needs arising from individual bodily functions or health conditions. After evolution, many scholars have added three aspects of environmental factors, behavioral factors and result factors on this basis, forming a four-dimensional model as a whole. Although Anderson's Behavioral Model is mostly used in the field of health services to analyze the behavior of health service utilization and explore the factors that affect the utilization of health services (Andersen, 1995), the use of elderly care services by the elderly is also a behavior, which is similar to the behavior of health service utilization. Today the model is widely used to study the use of services by the elderly. For example, a study based on the Andersen's Behavioral Model to study the impact of physical function trajectories on later long-term care utilization among the Taiwanese elderly (Hsu, 2013). Another study used the Andersen's Behavioral Model of health care utilization to analyze the association of health care costs with predisposing, enabling, and need factors in the German elderly population (Heider et al., 2014). In addition, the model incorporates possible influencing factors into a simple, clear and reasonable analysis framework, which guides empirical research to a certain extent and effectively avoids the random and unscientific selection of influencing factors. After many revisions and improvements, the model has been considerable maturity.

For the above reasons, this paper draws on Andersen's Behavioral Model. The explanatory variables select various factors that may have an impact on the elderly care service demand, and then construct a research model for this paper, as shown in Figure 1.

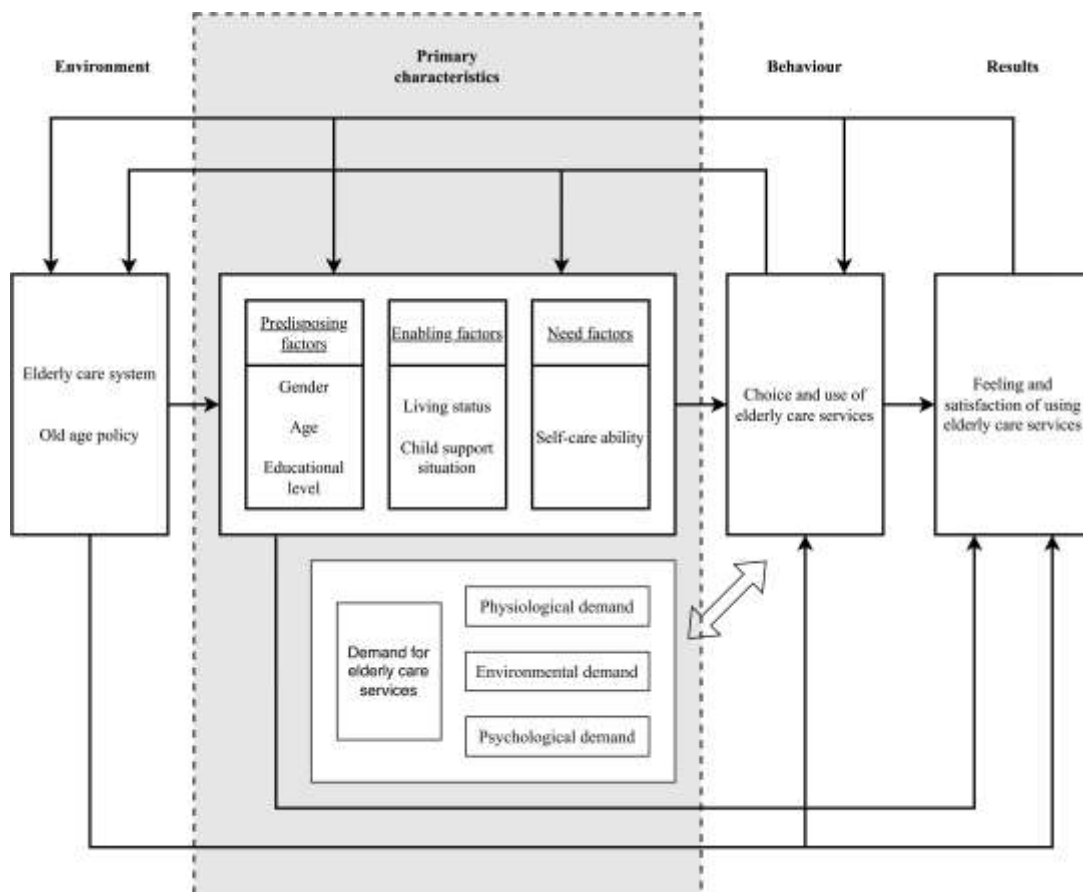


Figure 1: Research model on factors influencing the demand for elderly care services

Under the specific situation of the elderly choosing elderly care services, the environment in the four-dimensional model refers to the elderly care service system and related policies in the region where the elderly live, and the primary characteristics are three dimensions: predisposing factors, enabling factors and need factors. Behavior refers to the choice and use of elderly care services by the elderly, and the result is the feeling and satisfaction of the elderly after using elderly care services. The arrows in the above model indicate that the environment, primary characteristics, and behavior all affect the final result, and the final result in turn affects the above three dimensions. The environment and the primary characteristics will determine the behavior

of elderly care services, and the behavior will further affect the results. At the same time, the behavior and the result will have negative feedback on the primary characteristics and environment, and the result will also have an impact on the behavior.

In terms of needs classification, this paper takes Maslow's Hierarchy of Needs Theory as a reference. Maslow's Hierarchy of Needs Theory believes that human needs are hierarchical, and there is a process of development from low level to high level. It divides people's innate needs into five levels, namely, physiological, security, belonging and love, respect and self-realization. Because the boundaries of some elderly care service items are not clear enough at present, they cannot specifically correspond to the five levels of the Hierarchy of Needs Theory. Therefore, based on the basic idea of the hierarchy of needs theory and combined with previous research (Stein et al., 2016), this paper divides the needs of the elderly into physical demand, environmental demand and physical demand. Physiological demand refer to the needs of the elderly to ensure their own body cleanliness, physical health, food and clothing, etc. environmental demand refer to the needs of the elderly in terms of living environment and cleaning, placement and maintenance of household items in order to gain self-respect. physical demand are the needs of the elderly in social interaction, learning and entertainment in order to resolve the loneliness caused by the lack of social roles and reduced participation in social activities.

Research Hypothesis

People's subjective consciousness is generated under the action of numerous and complex objective factors, and the same is true for the elderly's demand for elderly care services. Since the research data in this paper comes from the elderly care service information system, which mainly includes service records and personal characteristic data of the elderly, it is difficult to conduct in-depth research on the environment, behavior and results in the above theoretical model based on this data. Therefore, under the guidance of Anderson's Behavioral Model, this paper mainly studies from the perspective of the primary characteristics of the elderly. The hypothesis is developed from three aspects: predisposing factors, enabling factors and need factors of the primary characteristics dimension.

Predisposing factors

The predisposing factors mainly refer to demographic factors. Combined with the model and previous research, the variables included in this paper are gender, age, and educational level.

As far as gender is concerned, due to the different physiological structures and perspectives and degrees of perception of the outside world between male and female elderly, female elderly are usually in a vulnerable group, and their self-protection ability is lower than that of men (Roth & Basow, 2004). In addition, women usually have a higher average life expectancy than men and have a correspondingly higher proportion of chronic diseases (Lee et al., 2020). Elderly people of both sexes often have different needs for elderly care services. Therefore, this study assumes that:

H1: gender will significantly affect the demand for elderly care services. Compared with male elderly, female elderly have more physical and environmental demand.

Regarding age, age reflects the physical condition of the elderly to a certain extent. With the continuous growth of age, the physical activity of the elderly gradually declines and the risk of disease increases. At the same time, the psychological will also produce more loneliness. In turn, there will be a demand for diversified elderly care services. Many studies believe that from the perspective of the demand for elderly care services, the older the elderly, the higher the demand (Lengenfelder et al., 2019; Bock et al., 2014). The specific differences are reflected in the types of elderly care services. Research has found that the older the elderly have higher physical demand such as leisure and entertainment. Therefore, this study assumes that:

H2: age will significantly affect the demand for elderly care services, and older elderly have more physical demand than younger elderly.

Looking at the educational level, generally speaking, with the improvement of the level of education, people's minds will be relatively open, and it will be easier to accept new things in society. And different educational levels affect the demand for different types of resources, for example, the literate elderly can go out to see a doctor, get a haircut, eat, etc. alone, while those who are illiterate often need help from others if they want to strengthen their social connection and obtain medical services (Shi et al., 2021), which will generate more needs in this regard. Therefore, this study assumes that:

H3: the educational level will significantly affect the elderly's demand for elderly care services. The elderly with low educational level have more physiological demand than the elderly with high educational level.

Enabling factors

Enabling factors refer to the resource conditions that affect the elderly's access to and use of elderly care services, including from both individuals and families. This article is condensed into two variables: living status and child support situation.

Regarding the living status, the family plays a vital role in the elderly care stage, and the family is often an important spiritual and material support for the elderly care (Heller & Factor, 2008). To a certain extent, the living style of the elderly determines the convenience of receiving help and care from family members and the satisfaction of their spiritual, emotional and material life, which in turn affects their demand for elderly care services and the type of demand. In addition, social development determines that the elderly will pay more attention to the needs for spiritual comfort after the material needs are guaranteed

(Wenfeng & Bingkun, 2021), especially the elderly who live alone are prone to loneliness and have more physical demand. Therefore, this study assumes that:

H4: the living status will significantly affect the demand for elderly care services, and the elderly living alone have greater physical demand.

As for the variables of child support situation at the individual level, elderly care services are actually a commodity for the elderly, which determines that the elderly must have a certain purchasing power in order to obtain services. Many studies have confirmed that material basis and economic ability are the basis for the demand for elderly care services (Li & Tracy, 1999; Ahn & Kim, 2004). The child support situation reflects the financial resources of the elderly from the side. The elderly who do not rely on their children for financial support usually have their own financial resources and have more space and freedom in economic control, which affects the type and frequency of their purchase of elderly care services. According to the Hierarchy of Needs Theory, the economically well-off elderly will continue to pursue more advanced needs after their physiological demand are basically satisfied, that is, the elderly who do not rely on their children for financial support usually have more environmental demand. Therefore, this study assumes that:

H5: child support situation will significantly affect the demand for elderly care services. The elderly who do not rely on their children for financial support have more environmental demand than those who rely on their children for financial support.

Need factors

Need factors refer to the needs of individuals due to their physical health. This paper mainly includes the variable of the elderly's self-care ability.

Regarding self-care ability, many studies have pointed out that physical condition is a rigid constraint for the elderly to form the demand for elderly care services (Høy et al., 2007; Nie et al., 2008). Compared with young people, the self-care ability of the elderly will decline, weaken or even lack. The elderly without self-care ability will not only be restricted in free activities, but also require long-term care to meet their basic physiological demand. Therefore, this study assumes that:

H6: self-care ability will significantly affect the demand for elderly care services, and the physically disabled elderly have more physiological demand.

Interaction effects

There are many factors that affect the demand for elderly care services. According to Anderson's Behavioral Model, among the above three types of factors, different factors have different effects on the demand for elderly care services, both directly and indirectly. Considering that the impact of the above-mentioned factors on the demand for elderly care services is likely to be affected by other factors, this paper adds pairwise interaction terms between different categories of factors on the basis of the original model, trying to improve the regression model and study the interaction of factors. Therefore, this study assumes that:

H7: the interaction between different categories of factors will have a significant impact on the elderly's demand for elderly care services.

Based on the above, the research hypotheses are summarized in Table 1 below.

Table 1: Summary of research hypothesis

No.	Hypothetical content
H1	Gender will significantly affect the demand for elderly care services. Compared with male elderly, female elderly have more physical and environmental demand.
H2	Age will significantly affect the demand for elderly care services, and older elderly have more physical demand than younger elderly.
H3	The educational level will significantly affect the elderly's demand for elderly care services. The elderly with low educational level have more physiological demand than the elderly with high educational level.
H4	The living status will significantly affect the demand for elderly care services, and the elderly living alone have greater physical demand.
H5	Child support situation will significantly affect the demand for elderly care services. The elderly who do not rely on their children for financial support have more environmental demand than those who rely on their children for financial support.
H6	Self-care ability will significantly affect the demand for elderly care services, and the physically disabled elderly have more physiological demand.
H7	The interaction between different categories of factors will have a significant impact on the elderly's demand for elderly care services.

Data Collection

The data in this paper comes from an elderly care service information system adopted by a city in Sichuan Province, China. The system acts as an intermediary platform to connect with the government, the elderly and elderly care service providers (elderly care institutions, communities, enterprises, etc.), the government issues pensions and pensions in the form of points through this system. As the only official old-age care system designated by the local government, the old-age service information system covers all the elderly in the area. As a regulator, the government strictly controls the quality of service

institutions, and every service record in the system is objective and true, and can reflect the real needs of the elderly. Based on the above, we believe that it is more appropriate to use the service data in the elderly care service information system for research, and the sample data is both representative and authentic. This paper selects the service data of the elderly in a certain area in the system in the past three years as the research data, with a total of 142,477 items.

Variable Measurement

On the one hand, service data can reflect behavior. The service data selected in this paper is essentially behavioral data, and the service data in the elderly care service information system is the consumption records of the elderly on products such as "elderly care services". What these consumption records reflect is the consumption behavior of the elderly towards "elderly care services". On the other hand, behavior further reflects needs. Management believes that the generation of human behavior is based on needs and motivations. Demands can make people generate behavioral motivations, and motivations induce people to act to meet needs. The reason why the elderly "choose to use elderly care services" is driven by their own elderly care needs. Because the original data presented in the old-age service information system is the content of specific service items, it is not classified according to needs. Therefore, this paper reclassifies the service items in the service data according to Maslow's Hierarchy of Needs Theory. The new field is named "Demand Type", which is used as an explained variable, and the values are "Physiological Demand", "Environmental Demand" and "Psychological Demand". The correspondence between the types of elderly care service needs and specific service contents is shown in Table 2.

Table 2: The type of elderly care service needs corresponds to the specific service contents

Demand type	Specific service contents
Physiological Demand	Nail cutting service, hair cutting service, excrement cleaning service, hair washing service, foot washing service, hair washing service, health examination, hospital care, caregiver care training, body massage, meal feeding service, meal delivery service, etc.
Environmental Demand	Installation of light bulbs, water and electricity security inspection, gas security inspection, glass cleaning, range hood cleaning, cleaning, air conditioning cleaning, door-to-door washing services, etc.
Psychological Demand	Reading and newspapers, accompanying chat, holiday condolences, etc.

Then, based on the actual situation of the data, combined with the Anderson's Behavioral Model, this study extracts six variables from the system in three aspects: predisposing factors (Gender, Age, Educational level), enabling factors (Living status, Child support situation) and need factors (Self-care ability) as explanatory variables. The original data is uniformly entered into the system by the relevant personnel of the pension service information system and updated regularly.

In order to make the model estimation more accurate, the collinearity diagnosis is carried out before the regression, which can effectively avoid the influence caused by the special correlation between the explanatory variables. It is generally believed that when $0 < \text{VIF} < 10$, there is no multicollinearity. The results show that the tolerance of each variable is greater than 0.1 and the variance inflation factor VIF is less than 2, so the collinearity diagnosis result is good, and the next logistic regression modeling can be carried out.

The values and assignments of the explained variables and explanatory variables are shown in Table 3. All variables here are categorical variables.

Table 3: Variable value and assignment

Variable category	Variable name	Variable encoding
explained variable	Demand Type	0 = Physiological demand; 1 = Environmental demand; 2 = Psychological demand
	<i>Predisposing factors</i>	
	Gender	0 = Female; 1 = Male
	Age	0 = 60-69 years; 1 = 70-79 years; 2 = 80-89 years; 3 = Above 90 years old
explanatory variables	Educational level	0 = Uneducated; 1 = primary school; 2 = Junior high school and above
	<i>Enabling factors</i>	
	Living status	0 = Living alone; 1 = Living with spouse; 2 = Living with spouse and children; 3 = Living with children
	Child support situation	0 = Non-child financial support; 1 = Child financial support
	<i>Need factors</i>	
	Self-care ability	0 = Mild disability; 1 = Moderate disability; 2 = Severe disability; 3 = Normal

RESULT AND DISCUSSION

Descriptive Statistics

Firstly, this study provides statistics on the types of demands for elderly care services. The results show that the demands of elderly people for elderly care services are mainly focused on physiological demand and environmental demand, each accounting for 42.5% and 43.9%, while physiological demand account for only 13.7%. The results of the descriptive statistical analysis of the influencing factors are shown in Table 4. 48.5% of the services in the elderly care information system were provided to male older people, slightly less than the 51.5% provided to female older people, which was balanced overall. In terms of age structure, the majority of elderly people aged 60 to 69 used the services, accounting for 43.3%. 80 years old and above used the services the least, accounting for 20.7%. The overall age distribution is relatively reasonable. In addition, only 2.8% of the services were provided to elderly people with junior secondary education and above, which may be related to the generally low literacy level of elderly people in the region due to the overall low level of education in the 1950s or 1960s. In terms of living status, the largest proportion of elderly people living with their children used the services, at 38.8%. Older people living alone accounted for the least amount of service use, at 20.2%. In terms of child support situation, only 18% of older people who rely on their children for support use the service, indicating that those with more stable financial resources use the service more. In terms of self-care ability, 67.5% of older people with varying degrees of physical incapacity use services.

Table 4: Descriptive statistics of the basic characteristics of the sample

Variable	Classification	Number of people	Percentage(%)	Average value	Standard deviation	
Predisposing factors	Gender	Male	63556	51.5	0.49	0.500
		Female	59876	48.5		
	Age	60–69 years	53420	43.3	0.82	0.867
		70–79 years	44391	36.0		
		80–89 years	19765	16.0		
		Above 90 years old	5856	4.7		
		Uneducated	45894	37.2		
Educational level	Primary school	74092	60.0	0.66	0.531	
	Junior school and above	3446	2.8			
Enabling factors	Living status	Living alone	24926	20.2	1.78	1.163
		Living with spouse	25523	20.7		
		Living with spouse and children	25042	20.3		
		Living with children	47941	38.8		
	Child support situation	Non-child financial support	101167	82.0	0.18	0.385
		Child financial support	22265	18.0		
Need factors	Self-care ability	Mild disability	24595	19.9	1.67	1.126
		Moderate disability	31129	25.2		
		Severe disability	27542	22.3		
		Normal	40166	32.5		

One-way Analysis of Elderly People's Demand for Elderly Care Services

This paper begins with a one-way analysis of variance using the χ^2 test to initially explore which factors influence the demand for elderly services. The results show that the six factors of gender, age, education level, living status, child support situation and self-care ability are statistically significant ($P < 0.05$) in terms of differences in the demand for elderly care services, meaning that they are related to the demand for elderly care services. Therefore they can be included in the subsequent logistic regression analysis model to further verify the relationship.

Logistic Regression Analysis of the Influencing Factors of Elderly People's Demand for Elderly Care Services

Since the explanatory variable "type of demand for elderly care services" is a three categorical variables variable, this paper chooses the multiple logistic regression analysis. The final five variables that entered the regression model were age, living status, self-care ability, education level and child support situation, all of which have a significance level P of less than 0.05. Furthermore, the order in which the variables are entered into the model shows that age is the most significant influencing factor on the demand for elderly care services. Gender does not pass the significance test here, which indicates that although gender difference has an effect on the demand for elderly care services, this effect is not significant. Therefore the hypothesis 1 doesn't hold.

In this paper, 'physiological demand' is chosen as a control item to compare with other options and the model measures the odds ratio (OR). The odds ratio represents how many times more likely the reported choice item is to occur than the control

group, and in this paper is a direct reflection of the older person's propensity to demand. $OR > 1$ means that older people have a greater need for this type of service than the control group (physiological demand), i.e. there is a 'positive' association between the influencing factors and the need for this type of service. $OR < 1$ means that older people have more physiological demand and that there is a negative association between the influencing factor and demand for that type of service. Table 5 shows the results of the multiple logistic regression analysis.

Table 5: Results of multiple logistic regression analysis for types of demand for elderly care services

Variable	Psychological demand (Control item = Physiological demand)			Environmental demand (Control item = Physiological demand)		
	<i>B</i>	<i>P</i>	<i>OR</i>	<i>B</i>	<i>P</i>	<i>OR</i>
<i>C</i>	-1.316	0.000*		-0.016	0.739	
Predisposing factors						
Age(Control item = Above 90 years old)						
60–69 years(<i>Age</i> ₀)	0.319	0.000*	1.376	0.350	0.000*	1.418
70–79 years(<i>Age</i> ₁)	0.211	0.000*	1.235	0.187	0.000*	1.206
80–89 years(<i>Age</i> ₂)	0.109	0.023*	1.115	0.019	0.550	1.020
Educational level(Control item = Junior school and above)						
Uneducated(<i>Educational level</i> ₀)	-0.108	0.055	0.898	-0.219	0.000*	0.804
Primary school(<i>Educational level</i> ₁)	-0.064	0.246	0.938	-0.163	0.000*	0.850
Enabling factors						
Living status(Control item = Living with children)						
Living alone(<i>Living status</i> ₀)	0.061	0.016*	1.063	-0.002	0.917	0.998
Living with spouse(<i>Living status</i> ₁)	-0.068	0.006*	0.934	-0.147	0.000*	0.863
Living with spouse and children(<i>Living status</i> ₂)	0.036	0.150	1.037	-0.008	0.632	0.992
Child support situation(Control item = Child financial support)						
Non-child financial support(<i>Child support situation</i> ₀)	0.044	0.063	1.045	0.038	0.020*	1.039
Need factors						
Self-care ability(Control item = Normal)						
Mild disability(<i>Self-care ability</i> ₀)	-0.114	0.000*	0.892	-0.073	0.000*	0.930
Moderate disability(<i>Self-care ability</i> ₁)	-0.090	0.000*	0.914	-0.081	0.000*	0.922
Severe disability(<i>Self-care ability</i> ₂)	0.012	0.640	1.012	-0.101	0.000*	0.904

* $p < .05$

Results and analysis related to psychological needs

Using physiological demand as a control, the significant factors influencing the psychological needs of older people are age, living status and self-care ability, all of which have significance at the 5% level. Gender, educational level and child support situation did not pass the significance test and there is reason to believe that the differences in these three variables by themselves do not have a significant impact on the psychological needs of older people for elderly care services.

Firstly, the predisposing factors. In terms of age, the regression coefficients for *Age*₀、*Age*₁、*Age*₂ are all positive, indicating that the psychological needs of older people for elderly care services are positively influenced by age relative to physiological demand, with older people having more psychological needs. This is mainly because older people have more psychological needs as they get older and become less involved in outside activities, which in turn leads to them closing themselves off and becoming internally bored. According to the *OR*, the psychological needs of older people in the age group 60-69 are 1.376 times greater than their physiological demand. Based on the above analysis, the hypothesis 2 holds.

Secondly, the enabling factors. In terms of residence status, the regression coefficient for *Living status*₀ is positive, indicating that living alone has a positive impact on the psychological needs of older people. While the regression coefficient of *Living status*₁ is negative, indicating that living with a spouse has a negative effect on the psychological needs of older people in terms of elderly services. According to the *OR*, older people who live alone are more likely to have psychological needs as opposed to physiological demand. This possibility is approximately 1.063 times more likely than the tendency to have physiological demand. This result confirms the important role of family members in the later years of life of older people. Family members are not only a source of help and material support for the elderly, but also a source of spiritual support and comfort. Older people who live with their spouse tend to have more physiological demand than those who live with their children, about 1.07 times more than their psychological needs. This further reflects the different roles played by spouses and children in the later years of life, as children are not able to be with the elderly as often as they would like due to work, and the companionship of the spouse can alleviate the feeling of emptiness and loneliness. However, as spouses are also part of the elderly population and have a limited caring role, these older people often have more physiological demand. This may also be the reason why the presence of a spouse leads to overlapping of needs. Based on the above analysis, the hypothesis 4 holds.

Thirdly, the need factors. In terms of self-care, the regression coefficients for both *Self-care ability*₀ and *Self-care ability*₂ are negative relative to physiological demand, suggesting that self-care ability inhibits the psychological needs of older people. This may be because older people with mild and moderate physical disabilities will focus more of their energy and financial resources on resolving their physiological demand as opposed to those with normal self-care abilities. Thus the hypothesis 6 holds.

Looking at the other two factors, the *OR* for both educational level and child support situation are close to 1, indicating that these two factors do not make much difference to older people in terms of their psychological and physiological demand for elderly care services.

Results and analysis related to environmental demand

Using physiological demand as a control, the significant factors influencing the environmental demand of older people are age and educational level in the category of predisposing factors, living status and child support situation in the category of enabling factors, and self-care ability in the category of need factors, all significant at the 5% level.

Firstly, the predisposing factors. In terms of age, the regression coefficients of *Age*₀ and *Age*₁ are both positive, indicating that age has a positive influence on the environmental demand of elderly people for elderly services compared to physiological demand. The *OR* values show that compared to physiological demand, those under 80 years of age tend to have more environmental demand than physiological demand. The reason for this is that as the elderly grow older they are less able to cope with the household chores of daily life, and the home-based nature of elderly services can solve this difficulty for the elderly. However, for more elderly people, their children or other family members usually prefer to have a dedicated person to take care of them. Therefore, there is less demand for elderly care services provided by the elderly care system. The age group of 80-89 did not pass the significance test and did not differ significantly. This may be because this group shares the characteristics of older people aged 90 and above, so there is little difference in the type of demand. In terms of educational level, both *Educational level*₀ and *Educational level*₁ regression coefficients are negative, indicating that the educational level of Uneducated and primary school have a negative impact on the environmental demand of elderly people for elderly services compared to the group of elderly people with educational level of junior school and above. This may be because environmental demand are not limited by the educational level of older people. So there is relatively less needs in the environment. On this basis, the hypothesis 3 holds.

Secondly, the enabling factors. In terms of living status, the regression coefficient for *Living status*₁ is negative, indicating that living with a spouse negatively affects the environmental demand of older people. In terms of *OR* values, older people living with a spouse have a tendency to have 1.158 times more physiological demand than environmental demand. This is mainly due to the fact that older people live with their spouses. The spouse is usually the primary caregiver for the older person, but both have reduced physical mobility and limited caregiving capacity, making it difficult to fully meet basic physiological demand. There is therefore a demand for elderly care services in this area. In terms of child support situation, the positive regression coefficient for *Child support situation*₀ indicates that older people who are not dependent on their children will have more environmental demand relative to those who are dependent on their children. The *OR* value shows that this is 1.039 times more likely than physiological demand. This validates hypothesis 5. Older people with relatively generous incomes are more likely to enjoy the various services offered by the information system for elderly services, thus showing more environmental demand. In contrast, older people who are supported by their children give priority to services that meet their physiological demand due to their limited financial resources. This also shows that affordability is the basis for the demand for elderly care services.

Thirdly, the need factors. For self-care ability, the regression coefficients for *Self-care ability*₀ and *Self-care ability*₁ are all negative, indicating that self-care ability relative to physiological demand has a negative impact on the environmental demand of elderly people for elderly care services. As can be seen from the results, the *OR* values for mild disability, moderate disability and severe disability are all less than one, indicating that older people with physical disability have a tendency to have more physiological demand compared to environmental demand. According to Maslow's Hierarchy of Needs, environmental demand are based on the condition that lower-level physiological demand are largely met, so older people with disabilities tend to have more physiological demand than environmental demand.

Logistic Regression Model Improvements

In some cases, the two variables combined create a new effect, namely the interaction effect. In order to make the model more accurate, this paper considers adding the interaction term to the main effects model to improve the model and observe how the interaction effect affects the demand for elderly care services. It should be noted that this study focuses on the interaction between different categories of characteristic factors, i.e. the interaction terms of predisposing factor*need factor, enabling factor*need factor and predisposing factor*enabling factor are added to the main effects model to construct an improved multiple logistic regression model. Using SPSS 19.0 to do regression analysis, the final variables entered into the regression model were age, living status, age*living status, self-care ability, age*self-care ability, educational level, educational level*self-care ability, living status*self-care ability, educational level*living status, a total of nine variables. The significant *P* for these nine variables is less than 0.05. This indicates that the interaction effect of the two variables does have a significant effect on the demand for elderly services. Therefore, hypothesis 7 holds. The most significant factor influencing the demand for elderly care services is still age, in keeping with the results of the main effects model. It is worth noting that in addition to

the 'gender' factor, which was not significant in the main effects model, the 'child support situation' factor, which was the last factor to enter the model in the main effects model, also became insignificant when the interaction term was added to the model. In the improved model, physiological demand was again selected as the control group.

The results of the regression analysis showed that there were significant interaction effects between predisposing factor and need factor, enabling factor and need factor, and predisposing factor and enabling factor. The 'gender' factor in the predisposing factor and the 'child support situation' factor in the enabling factor did not have significant interactions with the other categories of factors.

In terms of psychological needs, with the addition of the interaction term to the model, there is not much change in the influence of age and educational level in the older people's predisposing factors on the demand for elderly care services. However, the effect of self-care ability in the need factor on the demand for elderly care services changes from negative to positive, which is a significant change compared to earlier. In terms of environmental demand, with the addition of interactive variables to the model, the influence of the age factor on the demand for elderly care services does not change significantly. However, four factors of educational level, living status, child support and self-care ability significantly change the influence level on the demand for elderly care services. Among these factors, the three factors of educational level, child support situation and self-care ability changed from significant to insignificant ($P > 0.05$). The effect of the living status factor on the demand for elderly care services also changed from negative to positive. It is still significant but to a lesser extent, dropping from 1% to 5% significant.

In terms of interactions, firstly, the impact of self-care ability on the demand for elderly care services is influenced by age, with increasing age being accompanied by decreasing self-care ability which in turn affects demand. Secondly, among older people with the same level of self-care ability, their educational level plays a decisive role in the way they meet their needs, mainly in terms of accessibility to knowledge and openness to ideas among older people with disabilities. Older people with low levels of education are likely to have more information barriers and limited access to care services. Due to their frugality and traditional attitudes, their basic physiological demand are the first to be met when using an information system for elderly care services. Thirdly, the impact of self-care ability on the demand for elderly care services can also be influenced by living status. The regression results show that older people living alone with severe disability have higher psychological needs. For severely disabled older people, restricted mobility and loss of life coping skills often lead to emotional sensitivity and vulnerability. The lack of social roles also leads to low self-esteem. Therefore they need more psychological support. Fourthly, older people living alone or with their spouse have more physiological demand than those living with their children, for the same age group (especially for the 60-89 age group). Those living alone or with a spouse have a tendency to have more physiological demand due to the lack of physical care by their children. Fifthly, the impact of educational level on the needs of elderly people for elderly care services can be influenced by their living conditions. The essence of this is that the needs of elderly people for elderly care services are usually not met due to their own limited educational level, in which family members play a compensating role. Poorly educated older people have difficulty accessing information due to illiteracy or poor comprehension. They have to rely on the help of others to meet their needs, such as access to medical care.

CONCLUSION

Research Summary

This paper takes the elderly in a certain area as the research object, builds a research model based on Anderson's Behavioral Model, and uses the elderly service data in an elderly service information system to empirically analyze the influencing factors of elderly service demand. Based on the four questions raised above, this paper draws the following conclusions.

First, in terms of demand characteristics. In terms of service volume, male elderly people use services slightly less than female elderly people, but they are basically balanced. Elderly people aged 60-79 and those with physical disabilities have become the main group of people who use elderly care services. From the perspective of demand types, physiological demand and environmental demand are the main needs of the elderly at the current stage, and psychological needs are less, which is in line with Maslow's Hierarchy of Needs Theory.

Second, the factors that affect the demand for elderly care services. It can be found that different types of elderly care service demands have different factors that affect them. This study uses physiological demand as a reference to find that age, living status and self-care ability will significantly affect the psychological needs of the elderly; age, educational level, living status, child support situation, and self-care ability significantly affect environmental demand; while gender has no significant impact on the demand for both types of elderly care services.

Third, in terms of the specific impact of various factors on the demand for elderly care services, the research verifies the specific effects of predisposing, enabling factors and need factors on the demand for elderly care services.

In the dimension of predisposing factors: (1) There is no statistical difference between gender in terms of psychological and environmental demand for elderly care services, and it will not have a significant impact on it. This is consistent with most previous research results (Fernández-Olano et al., 2006), but also contradicts some research results (Zhang, 2021). This may be related to the differences in the level of development, pension policies and specific pension service items provided in the

sample regions. (2) Age has a significant positive impact on both psychological needs and environmental demand, indicating that older people tend to have more psychological and environmental demand than physiological demand, which is mutually confirmed with most research results (Lengenfelder et al., 2019; Hahn & Oishi, 2006). (3) Educational level only has a significant negative impact on environmental demand. The elderly with low education have a large demand for medical care and physical examination services due to their limited knowledge of reading and comprehension, but they have a lower demand for the environment that is not limited by educational level. This confirms the previous conclusions on the relationship between educational level, health literacy and the demand for elderly care services (Fernández-Olano et al., 2006; Shi et al., 2021; Eronen et al., 2021).

In the dimension of enabling factors: (1) Living status has a significant impact on psychological needs, but there are both positive and negative effects: the elderly who live alone have more psychological needs than the elderly who live with their children. This is consistent with previous research results (White & Casey, 2017; Teerawichitchainan et al., 2015). The elderly living alone are prone to other negative emotions such as depression, anxiety and loneliness due to the lack of family support and care in life and spirit. Compared with the elderly who live with their children, the elderly who live with their spouses have a greater tendency to have physiological demand. After all, spouses are also elderly and have limited physical mutual care, which is similar to the results of other studies (Pinquart & Sörensen, 2011). (2) The child support situation only has a positive and significant impact on the environmental demand, and the elderly care service demand is supported by a certain economic level. This is consistent with most research conclusions (Herr et al., 2014; Ahn et al., 2004), the better the economic situation, the greater the needs of the elderly, and the higher the level of needs.

In the dimension of need factors: self-care ability has a significant negative impact on both psychological needs and environmental demand, that is, self-care ability will inhibit the psychological needs of the elderly to some extent. For physically disabled older adults, physiological care needs are prioritized, while environmental and psychological needs are less urgent, which is similar to other studies (Canjuga et al., 2018).

Fourth, from the perspective of interaction, this study verifies that there is a significant interaction effect between predisposing factors and need factors, enabling factors and need factors, and predisposing factors and enabling factors, and preliminarily explores the specific interaction. Among them, the severely disabled elderly people living alone in this area have higher psychological needs and deserve special attention.

To sum up, the hypotheses established in this paper are summarized in Table 6.

Table 6: Summary of hypotheses

Factors	Demand Type			Hypotheses
	Environmental demand	Psychological demand		
Predisposing factors	Gender	not significantly	not significantly	Hypothesis 1 does not hold
	Age	Positive impact	Positive impact	Hypothesis 2 holds
	Educational level	negative impact	not significantly	Hypothesis 3 holds
Enabling factors	Living status	negative impact	both positive and negative impact	Hypothesis 4 holds
	Child support situation	Positive impact	not significantly	Hypothesis 5 holds
Need factors	Self-care ability	negative impact	negative impact	Hypothesis 6 holds
Interaction effects	There is a significant interaction effect between predisposing factors and need factors, enabling factors and need factors, and predisposing factors and enabling factors.			Hypothesis 7 holds

Contributions

Compared with previous studies, the contributions of this study can be summarized as follows:

(1) This study uses the service data in the elderly information system to quantitatively verify the influencing factors of elderly service demand. Most of the existing studies obtain research data through questionnaires or interviews, and the research results are vulnerable to external influences. This study selects service data that directly reflects the real needs of the elderly, which supplements and verifies the existing research results to a certain extent.

(2) This study investigated the interaction of factors influencing the demand for elderly care services. Existing studies have focused on the effects of different dimensions of influencing factors alone on the elderly's elderly care service needs. Specific to the application research of Anderson's Behavioral Model, the existing research only focuses on the independent influence of the three factors of predisposing, enabling and need, and rarely pays attention to the interaction between the factors. In this study, while focusing on the main effect, the research on the interaction effect between factors has been added, and the effect of improving the model has been achieved, which supplements and expands the existing research to a certain extent.

(3) In practical application, this research is of great significance to service providers, elderly groups and the elderly care service information system. The elderly group can obtain better services and improve the quality of their elderly care. Service providers can further understand the current situation of demand and improve the supply of services. The elderly care service system can improve its own system design and operation mechanism to achieve precision and personalization of elderly care services.

Suggestions

Based on the conclusions of this paper, the following countermeasures and suggestions are put forward for the provision of elderly care services and the construction of elderly care service information systems.

(1) Provide personalized elderly care services based on needs. From the results of this paper, it can be seen that the factors of the elderly, such as age, self-care ability, living status, child support situation, and educational level, are not the same. The free combination of different factors creates diverse individuals whose needs are different and constantly changing. Therefore, providing differentiated and personalized elderly care services based on demand can improve the utilization rate of elderly care services, and the elderly care service information system plays an auxiliary role in this process.

(2) Pay attention to the psychological needs of the elderly living alone at very high ages. The results of this study show that the elderly of high ages and living alone in this area have more psychological needs for elderly care services. In today's society, most of the elderly care for the elderly only pays attention to meeting the physical demand of the elderly and ignores their psychological needs. In fact, with the reduction of communication with the outside world and the lack of social roles, the elderly will feel empty, lonely and helpless, and are prone to have a negative attitude towards life, especially the elderly living alone. Relevant departments should also increase publicity efforts, calling on young children to give emotional support to their parents and elders, so as to alleviate the psychological needs of the elderly and realize the warmth of old age.

(3) Accelerate the intelligent transformation of the elderly care information system, and manage the elderly care service data in a classified and dynamic manner. The elderly's demand for elderly care services is affected by their own characteristics. The underlying raw data is usually multi-source and multi-dimensional. The data management situation determines the data utilization, so the elderly care service information system should firstly classify and manage the data related to the elderly. Build the personal files of the elderly, and on this basis, form the comprehensive ability assessment grade files of the elderly. In addition, since various data of the elderly are constantly changing, the elderly care information system should update the data regularly to ensure that the system is always as close to the current physical characteristics as possible when recommending personalized services to the elderly.

Deficiency and Prospect

Based on the data of an old-age service information system and guided by Anderson's Behavioral Model and Maslow's Hierarchy of Needs Theory, this paper studies the effects of three factors, namely, predisposing, enabling factors, and need factors of the elderly on their needs for elderly care services. The interaction between the three types of factors is also studied. However, due to limited time and data samples, this study still has some shortcomings. The practice of the elderly care service information system in China is still in the stage of development and improvement, and the data connection between the system itself and other institutions needs to be improved and enhanced. Therefore, the data fields that can be provided by the elderly care service information system at this stage are limited, which leads to certain limitations in the selection of explanatory variables in this study. With the opening of the data interfaces of all parties, more indicators can be selected as explanatory variables for research in the future, making the research results more comprehensive.

Based on the above research deficiencies and combined with the actual situation, there are several directions to expand our research in the future. First, in terms of sample data acquisition, a combination of field investigation and information system data can be adopted to make up for the shortcomings of a single research method, and sample data can be obtained from more regions to improve the representativeness and comprehensiveness of the research results. Secondly, the current research mainly starts from the primary characteristics of the elderly, but according to the analysis framework based on the Anderson's Behavioral Model, it can be seen that environmental factors such as the construction of the elderly care service system and elderly care policies will also affect the needs of elderly care services. In the future, environmental factors can also be incorporated into the model for analysis. Finally, when studying the interaction of influencing factors, considering that the number of interaction items added to the model should not be too many, the second-order interaction is mainly studied. However, the interaction of more types of variables is also worth studying. In the future, we can consider adjusting the variables included in the model to study the third-order interaction of influencing factors.

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Research on user participation behavior of mobile short video APPs: Taking Xiaohongshu as an example

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ABSTRACT

Short video apps for mobile devices are rising in popularity. Using Xiaohongshu as an example, this work carefully studies the user participation behavior of mobile short video Apps and contributes to the body of knowledge in the field of pertinent theoretical research. This study equips creators of short videos with the knowledge they require to improve user experience and content marketing on a more objective basis, as well as to enable app upgrading and optimization. The UTAUT theoretical model is used in this paper to develop hypotheses, which are then tested using survey data. Finally, the theoretical model and hypothesis are validated using multiple regression analysis and hierarchical regression analysis. The significant study results are as follows: Users' behavior is significantly influenced by social value, perceived entertainment value, individual innovation, facilitating conditions, and privacy security when using communities; by social value, individual innovation, facilitating conditions, and privacy security when participating in communities; and by social value, facilitating conditions, and privacy security when contributing to communities. Finally, it makes some suggestions for the long-term expansion of mobile short video apps based on the testing results.

Keywords: Xiaohongshu; user participation; influencing factors; behavioral research.

INTRODUCTION

Mobile short videos were created as a new media format as a result of the expansion of 5G networks and the full adoption of 4G networks in recent years. These developments also encouraged the continued growth of the social media business(Li, 2021). Mobile short video has been quickly adopted by people due to the fragmentation of its transmission style and the qualities of short and quick information. After "Tik Tok," a user-generated content (UGC) site, first appeared, it set off a never-ending Carnival of people making, watching, and sharing short videos(Fang et al., 2019). With 934 million short video consumers and a 90.5 percent utilization rate as of December 2021, the short video business has reached a mature stage of growth. The mobile short video market is expected to become more competitive in the future, despite the industry's promising future. Under the background that the user market tends to be saturated and it is difficult to attract new users, how to improve the stickiness of old users and gain competitive advantage has become a problem that needs to be considered for short video platforms.

Mobile short video apps differ from traditional social networking in several ways. Their user bases are frequently younger and extremely concerned with their personal data protection. They start using mobile short video apps because they are drawn to new technology. They are able to submit videos on the site and share their lives because of their particular ingenuity(Wang, 2020). Long-term exposure, however, may cause individuals to develop a fear of information disclosure, which makes them less willing to engage in the user community and use goods and services(Jin & Yu, 2021). Contributing content also involves substantial community involvement and usage. One form of entertainment cannot draw people into the community profoundly; it can only draw people into using the app. All of these impede user stickiness growth and are unfavorable to the creation of mobile short video apps.

With a concept and set of traits focused on people exchanging knowledge and sharing their lives, Xiaohongshu successfully captures the user market and eventually claims a position in this background(Sun & Ly, 2022). A "social + e-commerce shopping community" is the Xiaohongshu app. The most recent figures show that Xiaohongshu has more than 200 million active monthly users, 43 million+ sharers, and creates billions of note exposures and millions of video exposures daily. Its material covers a range of life and academic topics, including clothing, beauty products, food, travel, movies and television, books, and fitness. The reasons for Xiaohongshu's success as a representative example of the developing user generated content(UGC) community platform are worth investigating and discussing.

The purpose of this work is to investigate the elements that influence user participation behavior in mobile short video apps using xiaohongshu as the research sample. Scholars' perspectives on how user participation behavior is divided vary(Vroom & Jago, 1988). Based on the UTAUT model and the characteristics of short video, this paper also explains the concept of user participation behavior. Then, present hypotheses and create questionnaires, use statistical software spss23.0 to perform a series of scientific and meticulous analyses on the amassed effective sample data, and use multiple regression analysis and hierarchical regression analysis to confirm the theoretical model and hypothesis, in order to thoroughly explore user participation behavior in mobile short video apps. Finally, the article proposes appropriate actions, which offer an objective

foundation for the operation and future development of mobile short video apps, allowing short video operators to take appropriate action to enhance user experience and content marketing effectiveness, encourage the optimization and upgrading of mobile short video apps, and boost user interaction. The improvement of page structure, along with the optimization and upgrading of short video apps, can help users better understand each function's purpose when using the product, increase their willingness to contribute content, meet their social needs, and find value and satisfaction in the online virtual community. This study is innovative in that existing research on mobile short video apps frequently utilizes "Tik Tok" as an example and focuses more on the short video's communication style and marketing approach (Schellewald, 2021). The key to increasing user stickiness is Xiaohongshu's virtual community's significant content contribution. Therefore, the research approach differs from earlier studies, focusing more on the psychology of users and their participation in virtual communities.

LITERATURE REVIEW

Concept of user participation behavior

According to the literature, there are two types of engagement behavior that are more prevalent and important on social media:

1. **Community Participation:** Interpersonal communication between members, both online and offline, such as talking about issues affecting the group, taking part in community administration, and even organizing community events, is referred to as community participation (Hu et al., 2016).
2. **Content contribution:** It means that people actively contribute original articles, movies, photographs, etc. to the site. User behavior, brand commitment, product reputation, and perceived revenue are all intimately related to content creation, community involvement, and product innovation on social media (Lin et al., 2014).

It may be concluded that user engagement at a high degree and consistency is crucial for online communities to succeed (Xu & Li, 2015). However, in earlier studies, a different type of user interaction was frequently overlooked. Community use refers to merely browsing and reading content on social media platforms; it is a passive type of participation (Lutz & Hoffmann, 2017). Numerous studies have found that most participants prefer to learn more about other people while interacting with them less (Hartmann et al., 2015). Some research has argued for a more thorough understanding of this latency-related passive participation behavior in recent years (Long & Zhang, 2014). They contend that passive participation is not only pointless but may also produce beneficial effects for the outside world, such as effects related to reputation, reputation, and networks. Early reading and viewing experiences can really pave the way for more extensive participation (Yuan et al., 2021). Additionally, consumers may feel content and entertained via this passive participation process. As a result, This study also considers community use.

Model of user participation behavior

A mobile client, which is simply an information system, is the foundation of the mobile short video app, a social application. There are numerous theories that can explain user participation behavior, such as rational choice theory (Herfeld, 2020), technological acceptance model (Torres Albero et al., 2017), social cognitive theory (Schunk & DiBenedetto, 2020), etc., according to the analysis of the pertinent theories of information system user behavior. It is challenging to explain the state of mobile short video apps in the era of mobile Internet in many ways because these theories are primarily applied to research in the era of traditional media, the variables studied are relatively simple, and the consideration of external variables is not comprehensive enough.

This paper claims that the unified theory of acceptance and use of technology (UTAUT) put forth by Viswanath (2003) is the most appropriate model for this work based on an analysis of the pertinent theories of user behavior. On the one hand, UTAUT is a traditional model for the adoption of information technology, on the other hand, the model has strong scalability and may suitably include corresponding external components (Sharma, 2020). UTAUT has currently been used in numerous kinds of APP user behavior study. Tak and Panwar (2017) looked into the variables that affected Indian mobile app users' purchasing decisions. It illustrates how habits have a significant impact on users' intentions. Alhadid et al. (2022) investigated several aspects that influence the use of the SANAD app as a health protection tool using mature models like UTAUT, TAM, and extended PBT. All of the variables in UTAUT have substantial effects, according to the findings. In order to develop niche tourism, Wu and Lai (2021) examined the elements influencing the behavior of film visitors on the Chinese Mainland and developed promotion methods for destination governments. They also gave insight for the creators of augmented reality tourism applications.

RESEARCH DESIGN

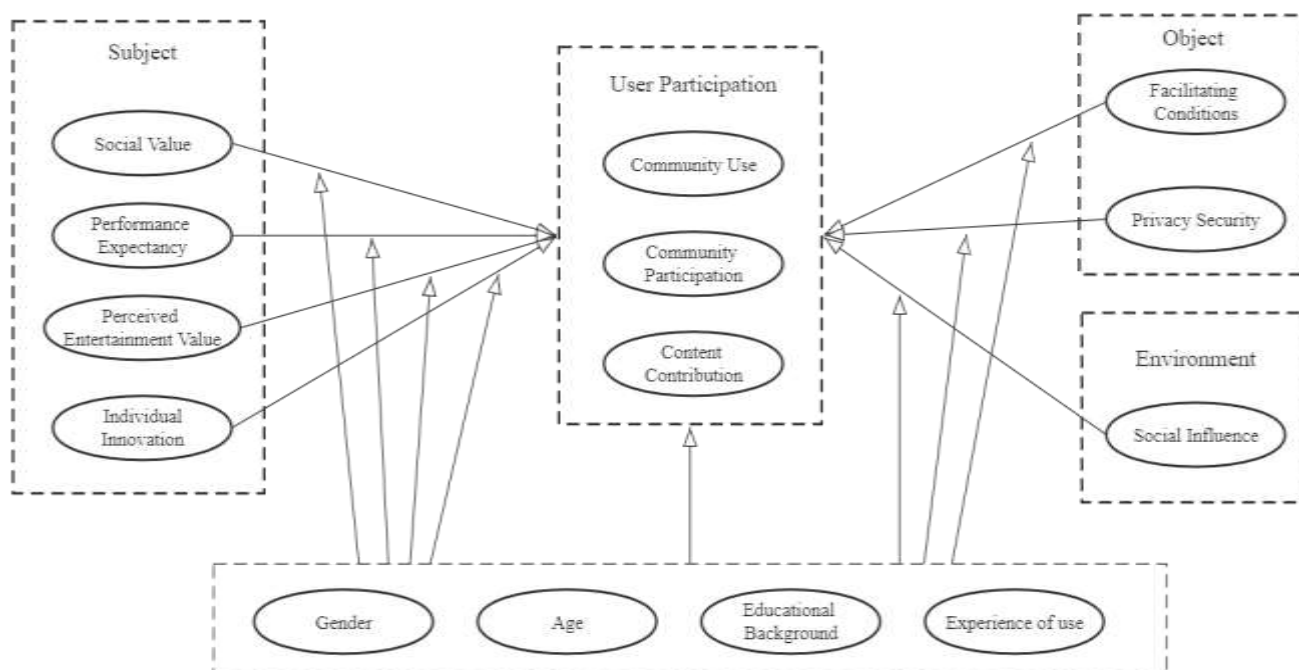
Research Model

The UTAUT model incorporates a number of earlier theoretical frameworks and proposes four fundamental variables: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), and Facilitating Conditions (FC); in addition, it also proposes four regulatory variables: gender, age, experience, and voluntariness of use. Since the majority of Xiaohongshu's users come from generations that were born in the 1990s and are known for being open to trying new things, including short video apps. The voluntariness of use is therefore outside the purview of this document. They don't make much of an effort to use the Xiaohongshu. Whether using APP will make them happier is a very unstable aspect. This study adjusts the definition and nomenclature of EE to Perceived Entertainment Value and in order to better meet this research issue.

As of right now, academics from a variety of fields have acknowledged the UTAUT model's dependability and accuracy, making it extensively used across many disciplines. Practice has shown that this model may explain user behavior with an explanatory power of up to 70%, outperforming several earlier conventional models. It provides a more thorough explanation of why users accept science and technology in particular. Users' acceptance of mobile short video APPs as a new information system in the age of intelligent Internet has had an impact on their varied APP activities. As a result, the UTAUT model is used as the foundational model in this study of user involvement behavior for mobile short video apps. New variables are added to the model in order to alter it for these apps' unique qualities and create an influencing factor. In order to build an influential factor model of user participation behavior of mobile short video app and make the model more scientific, this paper uses the UTAUT model as the foundational model to study the user participation behavior of mobile short video apps. Additionally, it introduces new variables to adjust the model in combination with the characteristics of mobile short video apps. Users may lose the urge to voice their opinions when utilizing virtual communities due to the numerous incidences of information leakage on the Internet and the associated risk of information leakage. Additionally, the user's educational background and capacity for invention may be related to the logical thinking and language organization required for the content creation on the APP. Therefore, "Individual Innovation," "Educational Background," and "Privacy Security" are the new factors. The users themselves, the APP being used, and the environment are all involved in the process of using mobile video APPs. Therefore, to more clearly separate the characteristics of variables, this study classifies variables into subject, object, and environment.

Hypothesis Development

The users of Xiaohongshu are used as the research subject in this paper, which develops a theoretical model based on the UTAUT model, modifies and eliminates the original UTAUT model variables appropriately by reviewing relevant literature and taking into account the actual situation, introduces four influencing factors—social value, perceived entertainment value, individual innovation, and privacy security—and divides these factors into three perspectives—subject, object, and environment. The primary variables are the internal variables that influence how Xiaohongshu is used by users; Object factors are those elements that have an impact on the Xiaohongshu platform itself; Environmental elements are those aspects of the outside environment that have an impact on how Xiaohongshu are used by users. In addition, it is suggested that gender, age, educational attainment, and usage experience along with the user's personal characteristics play a regulatory role in various factors. A model of influencing factors of mobile short video app user involvement behavior is created, as shown in Figure 1:



Source: This Study

Figure 1 Model of factors about user participation behavior in mobile short video apps

The following explanations of various factors have been updated in light of the research experience of scholars like V. Venkatesh and domestic scholars as well as the requirements of this paper:

1. User Participation: Community use, community participation, and content contribution make up the majority of user participation. Community use is one of them, which refers to more involvement in community engagement and communication as opposed to merely viewing and reading material on the Xiaohongshu platform; Communication between users, such as topic debate, helpful problem-solving, and even engagement in circle formation, is referred to as community participation. Contributing original articles, videos, photographs, and other types of content means that people will actively contribute to and enhance the content.

2. Social Value: It's the important element that Xiaohongshu users perceive in their interactions with one another.
3. Performance Expectancy: It's the notion held by consumers that using small Xiaohongshu can increase the effectiveness of information gathering.
4. Perceived entertainment value: It describes how much consumers think that Xiaohongshu can make them feel good and carefree.
5. Individual innovation: It describes a user's willingness to experiment with novel products, services, or systems.
6. Facilitating Conditions: The level of ease of using Xiaohongshu in relation to pertinent technologies and apparatus in the user's environment is referred to as facilitating conditions.
7. Privacy Security: The level to which users may safeguard their privacy information and minimize security threats while utilizing Xiaohongshu is referred to as privacy security.
8. Social Influence: It also known as the influence of users' immediate surroundings on users' usage of Xiaohongshu, as well as the public relations power of advising users to use Xiaohongshu.

The hypothesis of the link between various adjusting variables, such as gender, age, educational background and experience of use on user participation behavior is provided in Table 1 below. Among them, the influencing factors 2 to 8 are independent variables.

Table 1 Hypothesis

Number	Hypothesis
H1	Social value has a significant positive impact on user participation behavior
H2	Performance expectancy has a significant positive impact on user participation behavior
H3	Perceived entertainment value has a significant positive impact on user participation behavior
H4	Individual innovation has a significant positive impact on user participation behavior
H5	Facilitating Conditions has a significant positive impact on user participation behavior
H6	Privacy Security has a significant negative impact on user participation behavior
H7	Social Influence has a significant positive impact on user participation behavior
H8	Each variable plays a regulatory role in the impact of the above factors on user participation behavior

Source: This Study

Questionnaire

The survey questionnaire method is used in this paper to gather data, and it aims to include all types of Xiaohongshu users in the process. The questionnaire is based on a study of pertinent facts and prior literature research. Its material is split into two sections: the first includes personal fundamental information, and the second is a measurement scale of the factors that influence user participation behavior.

The first section's goal is to demonstrate how users actually utilize the product. It includes closed-ended questions about users' gender, age, educational attainment, and use experience as well as a scaled review of other comparable goods. The questionnaires and measurement items of various scholars who have studied participation behavior were consulted in the construction of the second section of this paper, which ultimately yielded 10 variables and 29 measurement questions. For specific questions, see Table 2.

Table 2 Measuring Scale

variable	Measurement items
Social Value	SV1: I can communicate with other users on Xiaohongshu
	SV2: I can communicate with my friends on Xiaohongshu
	SV3: I can make new friends on Xiaohongshu
Performance expectancy	PE1: I can get a lot of information such as news and food on Xiaohongshu
	PE2: I can get some valuable information such as life and study on Xiaohongshu
	PE3: I think Xiaohongshu is useful
Perceived entertainment value	PEV1: Using Xiaohongshu is enjoyable
	PEV2: Using Xiaohongshu is easy and relaxed
	PEV3: Using Xiaohongshu is interesting
Individual innovation	II1 : I'm curious about new platforms and technologies
	II2 : Among the people around me, I tend to be the first to use new technology products or services
	II3 : Generally speaking, I like to constantly try and accept new things
Facilitating Conditions	FC1 : When the mobile device network is good, the function and service of loading Xiaohongshu are smooth
	FC2 : When mobile devices operate stably, they respond quickly when using Xiaohongshu
	FC3 : If there is any problem, I can ask for help on Xiaohongshu
Privacy Security	PS1 : I'm worried that using Xiaohongshu will reveal my personal information

	PS2 : I'm worried that using Xiaohongshu will bring me safety risks
Social Influence	SI1 : I have friends who use Xiaohongshu
	SI2 : There are friends around me who think Xiaohongshu are useful
	SI3 : A friend around me suggested that I use the Xiaohongshu
Community Use	CU1 : I use Xiaohongshu frequently
	CU2 : I often use Xiaohongshu
	CU3 : I keep using Xiaohongshu
Community Participation	CP1: I help other users answer their questions on Xiaohongshu
	CP2: I participated in the discussion on community issues on Xiaohongshu
	CP3: I actively participate in relevant activities on Xiaohongshu
Content Contribution	CON1 : I often write articles and edit comments on Xiaohongshu
	CON2 : I often edit videos and comments on Xiaohongshu
	CON3 : I often add new videos and comments on Xiaohongshu

Source: This Study

Following design, the questionnaire was made available on social media platforms. Sample data was gathered, and 338 questionnaires were obtained. The questionnaires with too little time for answers or repeated questions back-to-back with the same response were removed to ensure the validity and dependability of the survey data. In the end, 291 legitimate questionnaires were kept, and the efficiency of the questionnaire was roughly 86.09 percent.

DATA ANALYSIS

Descriptive Statistics Analysis

The 291 valid survey responses in this study were from Xiaohongshu users in diverse geographical areas, see Table 3. There are roughly equal numbers of male and female survey participants across all age demographics and educational levels, and that the sample distribution is fair.

Table 3 Information of Xiaohongshu's Users

Statistical items		Value	Percentage
Gender	Male	145	49.83%
	Female	146	50.17%
Age	Under 18	26	8.93%
	18-25	163	56.01%
	26-35	52	17.87%
	36-45	35	12.03%
	Over 45	15	5.15%
Educational Background	Secondary Degree	84	28.87%
	Undergraduate Degree	185	63.57%
	Master's Degree and Doctor's Degree	22	7.56%
Time Spent Using Xiaohongshu	Within 2 Months	103	35.4%
	2-6 Months	62	21.31%
	6-18 Months	61	20.96%
	More than 18 Months	65	22.34%
Frequency of Using Xiaohongshu	Everyday	62	21.31%
	Once every 2-3 days	80	27.49%
	Once a week	50	17.18%
	Less than once a week	99	34.02%
Use Experience of Mobile Short Video APPs	Strongly Inexperienced	21	7.22%
	Inexperienced	45	15.46%
	Neither Inexperienced or Experienced	64	21.99%
	Experienced	90	30.93%
	Strongly Experienced	71	24.4%

Source: This Study

Reliability Analysis

The stability and consistency of the outcomes determined by the scale tool are referred to as reliability. The internal consistency of the scale and the reliability of each variable are tested using the Cronbach's alpha reliability coefficient in the SPSS 23.0 program. Table 4 displays the findings of the reliability analysis performed on the survey data used in this study. In general, a Cronbach's alpha value of 0.9 or higher indicates that a questionnaire is extremely reliable; 0.8 to 0.9 indicates that a

questionnaire is reliable; 0.6 to 0.8 indicates that a questionnaire's reliability is within acceptable bounds; and 0.6 or less indicates that a questionnaire's reliability is low. The table below shows that all variables' Cronbach's alpha values and the Cronbach's alpha values of removed items are larger than 0.75, most of which are above 0.8, demonstrating the questionnaire's strong internal consistency and stability as well as its good reliability.

Table 4 Reliability Analysis

variable	Cronbach' Alpha
Social Value	0.884
Performance Expectancy	0.879
Perceived Entertainment Value	0.898
Individual Innovation	0.879
Facilitating Conditions	0.844
Privacy Security	0.772
Social Influence	0.859
Community Use	0.922
Community Participation	0.919
Content Contribution	0.929

Source: This Study

Validity Analysis

Validity is the degree to which a trait may be accurately assessed by a test or scale, and it can be further broken down into three categories: construction validity, calibration relevance validity, and content validity. The content validity of the scale is good because each variable's measurement items were updated in accordance with prior academic literature; nevertheless, measuring calibration relevance validity requires external calibration instruments that have high levels of validity and reliability. There is currently no measurement scale for the involvement behavior of users of mobile short video apps, hence only the construct validity of the scale is assessed in this instance. Through factor analysis using the SPSS 23.0 statistical package, this research evaluates the construct validity of the scale. The scale's KMO value is 0.810 (> 0.5) indicates that the survey data can be used for factor analysis and that Bartlett's significance is less than 0.01, demonstrating the scale's sound validity structure and suitability for factor analysis. The retrieved 10 factors have enough information because the overall variance interpretation rate of this component is 83.29 percent, which is higher than 60 percent.

Principal component analysis was performed to extract the factors for this test, and maximum variance orthogonal rotation was employed to rotate the factor load matrix. Table 5 shows that there are 10 main components identified by the factor analysis, and that each item's load is greater than 0.8, demonstrating the high validity of this survey.

Table 5 Factor Analysis-Rotate Matrix Elements

	1	2	3	4	5	6	7	8	9	10
SV1	0.021	0.058	0.092	0.082	0.866	0.077	0.125	0.06	0.021	-0.046
SV2	0.064	0.053	0.11	0.052	0.897	0.001	0.102	0.093	0.049	-0.011
SV3	0.123	0.118	0.13	0.094	0.858	0.016	0.054	0.044	0.124	-0.039
PE1	-0.039	-0.07	-0.031	0.092	0.108	0.12	0.876	-0.01	0.071	0.027
PE2	0.065	-0.011	0.011	0.078	0.095	0.059	0.899	0.011	0.046	0.043
PE3	0.064	0.044	0.002	0.033	0.069	-0.01	0.874	0.05	0.125	-0.06
PEV1	0.086	0.059	0.017	0.884	0.053	0.042	0.065	0.068	0.139	-0.059
PEV2	0.099	-0.032	0.006	0.903	0.072	0.034	0.062	0.1	0.079	-0.011
PEV3	0.035	0.084	0.002	0.889	0.098	0.028	0.078	0.013	0.102	0.052
FC1	0.046	0.019	-0.014	0.185	0.016	0.044	0.135	0.047	0.837	0.004
FC2	0.061	0.015	0.067	0.103	0.062	0.044	0.106	0.063	0.889	0.007
FC3	0.118	0.191	0.115	0.038	0.116	0.118	0.006	0.026	0.816	-0.049
PS1	-0.103	-0.236	-0.092	0.039	-0.013	0.029	-0.016	-0.01	-0.034	0.864
PS2	-0.16	-0.06	-0.127	-0.052	-0.075	-0.134	0.025	-0.025	0.004	0.872
SI1	0.008	-0.032	0.01	0.063	0.055	0.023	-0.009	0.904	-0.022	0.031
SI2	0.052	-0.008	-0.005	0.003	0.064	0.034	0.004	0.898	0.046	0.022
SI3	0.051	0.086	0.106	0.115	0.069	0.117	0.062	0.818	0.116	-0.099
CU1	0.882	0.189	0.185	0.062	0.07	0.081	0.027	0.058	0.068	-0.065
CU2	0.908	0.098	0.092	0.052	0.073	0.076	0.04	0.04	0.081	-0.099
CU3	0.863	0.177	0.11	0.135	0.076	0.135	0.038	0.028	0.092	-0.136
CP1	0.107	0.883	0.184	0.035	0.073	0.067	-0.022	0.042	0.095	-0.064
CP2	0.162	0.873	0.212	0.039	0.076	0.162	-0.014	0.007	0.083	-0.129
CP3	0.234	0.824	0.193	0.061	0.114	0.184	-0.007	-0.009	0.059	-0.167
CON1	0.111	0.166	0.891	-0.023	0.156	0.131	-0.043	0.07	0.066	-0.071

CON2	0.154	0.176	0.892	0.058	0.123	0.148	0	0.06	0.066	-0.071
CON3	0.145	0.261	0.829	-0.01	0.103	0.21	0.023	-0.012	0.052	-0.13
II1	0.069	0.043	0.196	0.06	-0.011	0.865	0.125	0.084	0.097	-0.041
II2	0.186	0.242	0.218	0.002	0.057	0.822	0.025	0.026	0.023	-0.112
II3	0.051	0.111	0.057	0.045	0.055	0.884	0.034	0.073	0.086	0.016

Source: This Study

RESULTS

In this study, the model is tested and modified using regression analysis in SPSS 23.0. The three components of user engagement behavior—community use, community participation, and content contribution—can be seen from the examples above, thus we must verify the validity of each part's respective hypotheses. By defining H1 (a) - H8 (a) as the hypothesis used by the community use, H1 (b) - H8 (b) as the hypothesis of community participation, and H1 (c) - H8 (c) as the hypothesis of content contribution, this study refines the hypothesis.

Regression analysis results

We assess the model assumptions inferred in this study using the multiple regression analysis method, which employs the Stepwise method for analysis. Table 6 displays the findings of the regression analysis.

From the impact of various factors on community use, model 1 having the strongest explanatory power when the two variables Performance Expectancy and social influence are excluded. According to the beta value of the regression coefficient, the values for model 1 are, successively, -0.246, 0.2, 0.131, 0.116, and 0.102. If the beta value is negative, it means the independent variable has a negative influence on the dependent variable; if the beta value is positive, it means the independent variable has a positive influence on the dependent variable. Therefore, all five independent factors have a positive effect on community use, with the exception of "privacy security," which has a negative effect. Assume that H1(a), H3(a), H4(a), H5(a), and H6(a) are accurate, whereas H2(a) and H7(a) are unreliable.

Table 6 Regression analysis results

Model		Beta	T
1 community use	(constant)		3.002
	PS	-0.246	-4.601
	II	0.2	3.407
	PEV	0.131	2.112
	FC	0.116	2.074
	SV	0.102	1.995
2 community participation	(constant)		5.333
	II	0.266	4.994
	PS	-0.272	-5.176
	SV	0.135	2.557
	FC	0.121	2.27
3 content contribution	(constant)		3.65
	II	0.333	6.373
	SV	0.222	4.281
	PS	-0.196	-3.753

Source: This Study

From the impact of various factors on community participation, model 2's beta values are 0.266, -0.272, 0.135, and 0.121, respectively. All four independent factors have a positive effect on community participation, with the exception of "privacy security," which has a negative effect. Assume that H1 (b), H2 (b), and H3 (b) are false and that H4 (b), H5 (b), H6 (b), and H7 (b) are true.

From the impact of various factors on content contribution, the three independent variables in model 3 have respective beta values of 0.333, 0.222, and -0.196 from the viewpoint of the regression coefficient beta. The other two independent factors have a positive impact on content contribution, with the exception of "privacy security," which has a negative impact. Since H2 (c), H3 (c), H5 (c), and H7 (c) are not true, let's assume that H1 (c), H4 (c), and H6 (c) are true.

Hierarchical regression analysis is used in this research to determine whether each regulatory variable has a regulatory impact on the independent variables of each dimension. The results are displayed in Table 7 below using the adjustment test of gender on individual innovation and user community use as an example:

Table 7 Hierarchical regression analysis

Model	R	R ²	Adjusted R ²	Skew And Standard Deviation	R ² change	F Change	Significant F value change
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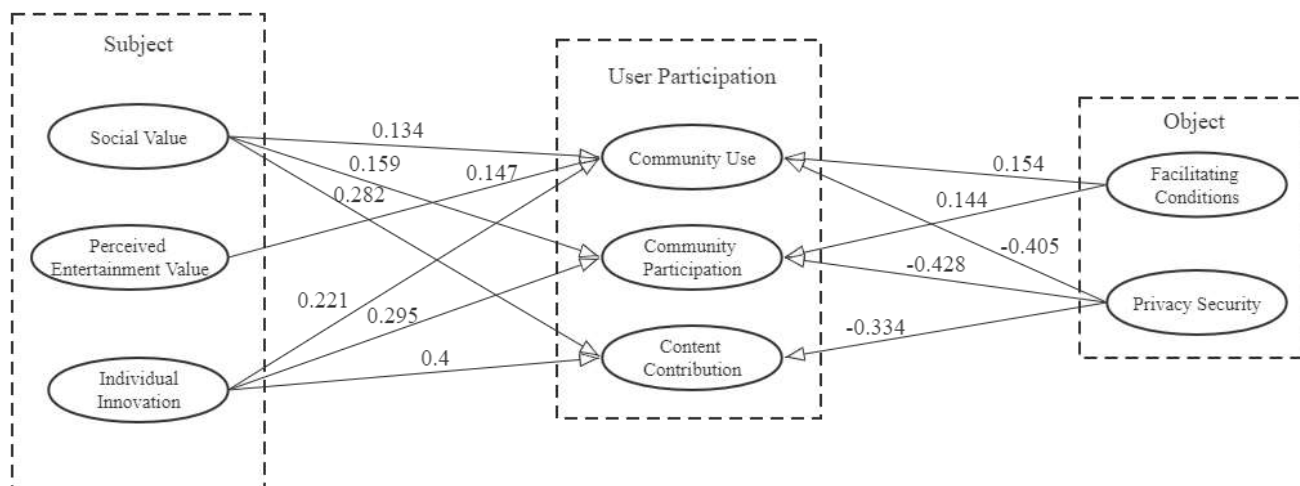
1	.284a	0.081	0.078	3.42583	0.081	25.408	0
2	.285b	0.081	0.075	3.43066	0.001	0.187	0.666

Source: This Study

The significance of the change in R² for the second model, which is shown in the table, is 0.666, which is much greater than 0.05, indicating that the regulation effect is not obvious. For the adjustment of gender to the other six independent variables, the corresponding significance of the test results is 0.916, 0.875, 0.960, 0.694, 0.607, and 0.895, all of which are much more significant than 0.05, and ultimately fail to reach the 0.05 significance level.

Model modification

The model of influencing factors of user participation behavior of mobile short video apps is adjusted in accordance with the findings of the hypothesis test, and the new model is obtained, as shown in Figure 2:



Source: This Study

Figure 2 Adjusted model about user participation behavior of mobile short video APPs

CONCLUSION AND RECOMMENDATIONS

This study examines the variables that affect user participation in a mobile short video app using qualitative and quantitative methodologies. A modified influencing factor model of user participation behavior for mobile short video apps is suggested based on the verification analysis of the survey results. In addition, the following recommendations are pertinent for app operators and based on the study's experimental findings:

1. To improve user experience, concentrate on simplifying product operation and related functions. When using the product, each user can immediately comprehend the purpose of each function and, thanks to its incredibly straightforward operation, produce the required effect. The platform's interface design should also be optimized, the community's page structure should be improved, and users should be encouraged to keep using mobile short video apps.
2. Boost the interactive entertainment design and the social aspect of the community. In order for consumers to completely experience the satisfaction and enjoyment given by mobile video applications and promote effective user interaction, the social network platform should place a high focus on satisfying users' social needs.
3. Pay attention to the user experience, keep an eye on it, and work to continually raise user satisfaction. Users' propensity to continue making product choices will be improved to some level once their expectations are met. Adhering to their own business and social principles should also be a key consideration. Users can only feel a certain level of community trust and be more likely to be satisfied by the platform by protecting their privacy.

CONTRIBUTIONS AND IMPLICATIONS

The purpose of this paper is to deeply explore the participation behavior of users in mobile short video apps and put forward corresponding targeted measures, so as to provide valuable reference for the long-term development of short video app. The main contributions of this study are as follows:

In terms of theoretical contribution, this work largely contributes to the body of knowledge on user behavior in mobile short video apps. User behavior research has been done on a variety of apps, according to a study of the literature. Short videos, on the other hand, have grown to be highly popular recently and have turned into apps that people use frequently and for extended periods of time. While there are a lot of studies on mobile short video apps are distributed on the current situation, future trends and marketing strategies, while the research on mobile short video app user behavior is relatively lacking. Based on the UTAUT model, this paper fuses the individual innovation theory with the social impact theory to create a model of the user

participation behavior of the mobile short video app. It then combines the survey data to thoroughly explore its influencing factors, with the goal of offering some references for future researchers in this field.

In terms of practical contribution, this study encourages the optimization and upgrading of mobile short video apps and offers an objective framework for their current and future growth. The research presented in this paper, specifically, can help mobile short video app operators better understand and meet users' needs from a variety of angles, offer some suggestions for the ongoing updating and development of mobile short video apps, and better provide references for short video operators on how to retain users and maintain platform traffic. In terms of the future development of mobile short video apps, it can offer useful and effective advice for the platform's future business development so that appropriate steps can be taken to enhance the user experience and the effectiveness of content marketing. At the same time, the app's improvement also provides the opportunity for users to use it with greater enjoyment, contribute to the app's content with greater assurance, and meet their social demands in the online community, such as finding the information they need and meeting new friends.

LIMITATIONS AND FUTURE RESEARCH

The study has some other restrictions as well. The majority of Xiaohongshu users are from post-90s generations, so they tend to be open to trying new things and find short video apps like Xiaohongshu to be relatively simple to use. Due to the post-1990s group characteristics and the virtual nature of the online community, social influence has not been confirmed. The only factor that significantly affects user participation behavior is facilitating conditions. In order to increase the generalization of the research model, the following study can use more adequate theoretical models and variables, and the sample selection will be closer to the present percentage of Xiaohongshu readers.

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RFL-based customer segmentation using K-means algorithm

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ABSTRACT

Customer segmentation has become crucial for the company's survival and growth due to the rapid development of information technology (IT) and state-of-the-art databases that have facilitated the collection of customer data. Financial firms, particularly insurance companies, need to analyze these data using data mining techniques in order to identify the risk levels of their customer segments and revise the unproductive groups while retaining valuable ones. In this regard, firms have utilized clustering algorithms in conjunction with customer behavior-focused approaches, the most popular of which is RFM (recency, frequency, and monetary value). The shortcoming of the traditional RFM is that it provides a one-dimensional evaluation of customers that neglects the risk factor. Using data from 2586 insurance customers, we suggest a novel risk-adjusted RFM called RFL, where R stands for recency of policy renewal/purchase, F for frequency of policy renewal/purchase, and L for the loss ratio, which is the ratio of total incurred loss to the total earned premiums. Accordingly, customers are grouped based on the RFL variables employing the CRISP-DM and K-means clustering algorithm. In addition, further analyses, such as ANOVA as well as Duncan's post hoc tests, are performed to ensure the quality of the results. According to the findings, the RFL performs better than the original RFM in customer differentiation, demonstrating the significant role of the risk factor in customer behavior evaluation and clustering in sectors that have to deal with customer risk.

Keywords: Customer risk, customer segmentation, RFM, data mining.

INTRODUCTION

Information technology (IT) and cutting-edge databases have revolutionized the way that organizations can manage their relationships with their customers and develop marketing strategies. Upon analyzing large amounts of data stored in such modern systems using data mining techniques, firms can identify the needs of their customers and improve their customer base (Taghi Livari & Zarrin Ghalam, 2021). In this fast-paced world where organizations are switching to conduct their businesses on electronic platforms, they must use this data to analyze their customer behavior as well. To achieve this, they can employ segmentation methods. What segmentation can provide them with is the opportunity to study changes in customer purchasing behavior, personalize after-sales services (Yan & Zhao, 2021), and identify profitable segments so as to develop tailored marketing programs (Mensouri et al., 2022). Segmentation divides a customer base into smaller groups, each of which contains broadly similar customers (Tabianan et al., 2022; Carnein & Trautmann, 2019). Using this approach, companies can also analyze customer segments' different values and risk levels, leading to gaining considerable knowledge about customers in order to mitigate their risks (Hanafizadeh & Rastkhiz Paydar, 2013). However, utilizing an appropriate segmentation approach based on customer data and mining them is still a challenge (Yan & Zhao, 2021).

The integration of segmentation approaches and data mining methods has recently gained popularity since it can reveal valuable information about diverse segments of customers. In this regard, the most frequently-used data mining technique has been clustering, which seeks to group samples with similar features (Carnein & Trautmann, 2019). Clustering algorithms, particularly K-means, are frequently integrated with customers' behavioral variables, the common of which are the purchase-related variables of RFM model (recency, frequency, and monetary value), to reveal hidden meaningful patterns and gain insight into customer behavior (Ernawati et al., 2021; Yan & Zhao, 2021; Zong & Xing, 2021; Li et al., 2020). The RFM model's simplicity and interpretability have been important factors in its popularity (Ernawati et al., 2022; Dogan et al., 2018).

Despite being simple to use and popular, RFM can be ineffective in customer differentiation as it neglects important factors such as customer risk (Yan et al., 2018; Singh & Singh, 2016). Recently, scholars have started to place a premium on addressing the risk of customers in classifying them (Singh & Singh, 2016). This is mainly because some customers may have purchased recently and have had frequent purchases with high monetary values while imposing high risks due to their costs (Yan et al., 2018). Considering these costs is crucial because if retaining relationships with customers is costly, this relationship will not create value for the organization (Zong & Xing, 2021) and will also expose the business to significant financial risks.

With the rapid development of online platforms and the fierce competition in the insurance industry, analyzing customer risks and their behavior has become vital (Yan et al., 2018; Hanafizadeh & Rastkhiz Paydar, 2013). In this sector, the losses incurred by customers and revenues (premiums) paid by customers are critical measures for managing and sustaining a profitable customer portfolio. As the losses imposed by customers and their paid premiums can differ significantly, profitability of the insurance companies can be influenced not only by their customers' paid premiums, but also their imposed losses (Ryals & Knox, 2005). For addressing these aspects of customer contribution to the company's productivity, the loss ratio, the ratio of the total incurred loss to the total earned premiums, can be utilized. This measure is an indicator of customer risk and a decisive factor in studying customer behavior in this sector (Esfandabadi et al., 2020).

Given the importance of addressing customer behavior and risk analysis, using insurance customers' data, we propose a novel risk-adjusted RFM, called RFL, by revising the M variable to be the L, the loss ratio. To the best of our knowledge, no remarkable study has been conducted on incorporating the insurance customer risk indicator in the RFM for the purpose of customer behavior analysis and clustering. Our approach can improve customer evaluation and enable managers to identify valuable and low-risk customers for developing customized marketing programs and managing customers.

This paper proceeds as follows: Section 2 summarizes the literature review. Section 3 discusses our research methodology as well as the experimental results. Section 4 describes the conclusions and makes suggestions for future studies.

LITERATURE REVIEW

Segmentation primarily refers to the process of dividing the whole customer base into internal-homogeneous segments (Carnein & Trautmann, 2019). It can group customers with similar features and behavior in order to provide them with better services, leading to an increase in the company's profitability (Wan et al., 2022; Zhuang et al., 2018). Segmentation has been conducted based on various variables. While general variables such as demographics and lifestyle have been ineffective in distinguishing customer behavior in some organizations, behavioral variables have assisted firms in effectively differentiating between non-profitable and profitable ones (Abbasimehr & Shabani, 2021). RFM variables are the most widely-utilized behavioral variables for customer segmentation (Mensouri et al., 2022; Ernawati et al., 2021). It provides a foundation for segmenting behavioral patterns regarding the transactions' recency (R), frequency (F), and monetary (M) values (Chou & Chang, 2022; Dogan et al., 2018). Recency is the time interval between the present and the last purchase time of a particular customer. The most-recent buyers, therefore, gain higher recency scores. Frequency refers to the number of purchases made by a customer and the higher the number of purchases is, the higher the frequency value would be. Monetary value is the total amount of money spent by a customer.

The RFM is well-known for its simplicity of implementation and understandability (Sarvari et al., 2016) due to which it has been frequently used in different areas and industries. For example, Tang et al. (2022) utilized a combination of RFM and the Naive Bayes method to study customer churn in the e-commerce industry. They highlighted that their proposed method can be employed for developing various marketing policies in order to reduce enterprise costs while improving its efficiency. The three RFM variables are also good variables for classifying customers. Besides, since the Naive Bayes method can easily determine the chance of loss of customers, its integration with RFM can help to detect which types of consumers are likely to lose. In another study, the RFM model was utilized for customer evaluation and classification by Mohammadian & Makhani (2019). In their investigation, customers were categorized into eight groups. Based on their findings, this model can aid companies in making better decisions to boost sales and improve marketing strategies in the competitive retail and fast-moving consumer goods contexts. Furthermore, Singh and Singh (2017) utilized structured (e.g., demographic, messages or number of minutes) and unstructured (e.g., location, customer feed-back, downloaded applications, online buying data) telecommunication data of customers. Their objective for conducting studying customers was not only to target important customers, but also to identify potential churn consumers. To achieve this, they employed RFM model to find diverse customer segments. In the next step, they designed tailored marketing campaigns according to the common features of each customer group.

Having said that, however, RFM model has some limitations, and one of them is that the significance and concepts of its variables vary among sectors (Chiang, 2019). To address this problem, RFM should be tailored to the particular characteristics of each industry, resulting in a more dependable and practical model (Martínez et al., 2021; Chiang, 2019). As a result, several modifications of this model are developed. For example, Hosseini et al. (2010) extended the RFM by adding product activity intervals for categorizing customer product loyalty in the automotive industry. They integrated the proposed model into the K-means algorithm and indicated that the proposed procedure could improve customer classification in this sector. Li et al. (2020) also adopted an approach for customer behavior analysis and exploring their needs in order to develop service marketing strategies based on customers' RFM values and an evaluation model. They used their method for analyzing customers of the platform of online education and classified customers considering IPA analysis and fuzzy evaluation.

Additionally, Chiang (2019) developed a revised RFM model called the FMA (frequency, monetary value, and the family travelers' average number) to be more suitable for the airline industry. They highlighted that the revised RFM could allow airline agencies to monitor customer value and plan diverse trip itineraries for various kinds of families. Wassouf et al. (2020) also proposed the TFM model, addressing the total length of calls and internet sessions (T), the frequency of service usage within a particular time frame (F), and the amount of money spent (M) in the telecommunication industry during a specified

period of time. They also incorporated demographic features of customers, including gender, age and their shared services. Based on the aforementioned features, they employed classification methods to build a predictive model for categorizing new customers based on their loyalty levels. Heldt et al. (2021) extended the RFM model to be the RFM/P model to combine the customer-centric and product-oriented viewpoints in order to envisage the customers' CLV (customer lifetime value) of a medium-sized supermarket and a financial service company more accurately. In another study, Singh and Singh (2016) stressed the significance of addressing risk in customer valuation and proposed an RFM-based approach for the direct marketing sector by considering risk measures, such as the likelihood of being active, regularity of purchases, and the possibility of reaching minimum purchase requirements as inputs and RFM as output. According to the authors, addressing risk can improve the accuracy of customer value analysis.

Recently, Ernawati et al. (2022) proposed the RFM-D model, where D is a district's potential, and employed K-means algorithm in order to identify target customers according to the university enrollment as well as spatial data of school in the educational institution context. The performance of their suggested approach was better than that of the RFM model developed based on CLV. In addition, Mensouri et al. (2022) extended the RFM by taking into account the interpurchase time and satisfaction as new dimensions. Using k-means, they clustered an e-commerce site's customers into 5 clusters and identified satisfied and unsatisfied segments of customers.

In the insurance industry, customers also demonstrate distinct behavioral patterns, and RFM should be adjusted to these characteristics as well. For example, Hamdi and Zamiri (2016) suggested a framework based on the RFM for customer segmentation by addressing the variety of insurance products purchased by customers as well as considering the frequency of insurance renewal and monetary value of the last policy purchase. In addition, Moeini and Alizadeh (2016) recommended using ARFM by incorporating age and SRFM by taking into account sex for customer loyalty analysis in the insurance industry and extracted different patterns. Finally, they analyzed customer damage for customer behavior analysis. Recently, Kalwihura and Logeswaran (2020) also proposed an approach for detecting fraud in the auto insurance business line based on RFM considering the recency of happening similar claim characteristics, frequency of happening characterized claims, time proportion (period of particular claim characteristic activity), and policy expiration. According to the authors, the traditional RFM-based segmentation model might ignore the internal-dissimilarities of insurance customers' claims within homogenous segments. Therefore, this model should be modified to properly analyze customer behavior.

According to the literature review, a myriad of businesses and industries can adapt and adjust the RFM for customer evaluation and segmentation. However, there is a scarce study on incorporating risk factors in RFM for analyzing customer behavior. Since the loss ratio is an indicator of customer risk in the insurance industry, this study aims to evaluate customer behavior using a risk-adjusted RFM named RFL, where L is the loss ratio.

RESEARCH METHODOLOGY

This study proposes an approach for analyzing and segmenting customer behavior based on a risk-adjusted approach that incorporates customer purchasing behavior as well as customer risk measure. To this end, this study modifies the RFM to be the RFL model, which addresses the recency, frequency, and loss ratio variables for analyzing the behavior of 2586 customers from an Iranian private insurance company. Various methods and algorithms have been used for segmenting and grouping customers based on their features. The K-means is the most extensively-used clustering algorithm in this field due to its fast operation, simplicity of analysis, and implementation (Anitha & Patil, 2022; Ernawati et al., 2021; Peker et al., 2017). The K-means algorithm, accordingly, is used in this study to cluster customers. Additionally, the results are analyzed using the analysis of variance and post hoc testing to see whether there is any significant cluster differentiation.

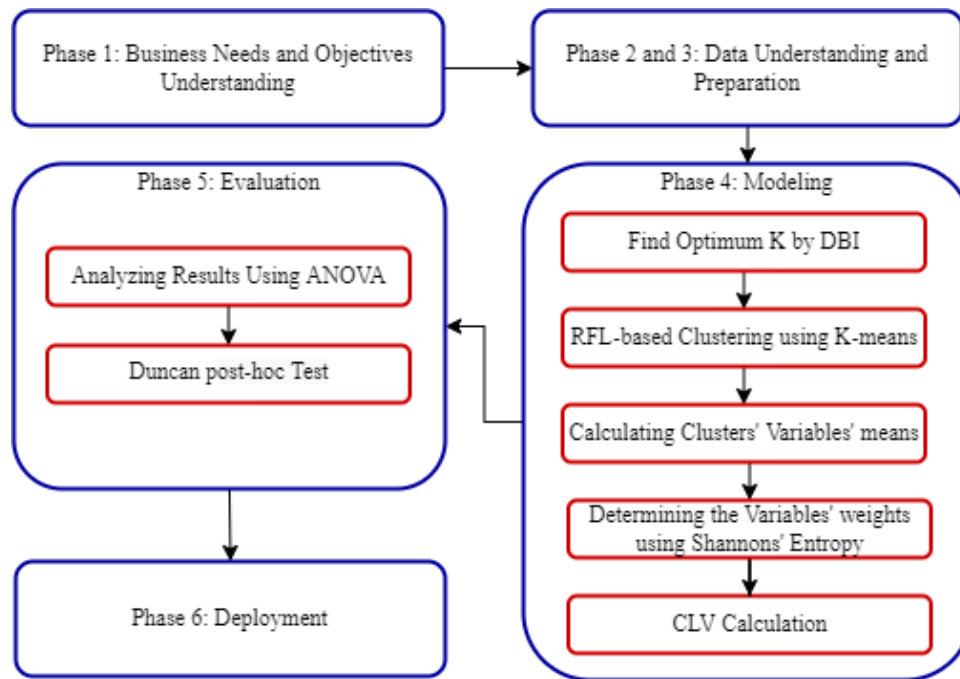
This study is conducted following the Cross-Industry Standard Process for Data Mining (CRISP-DM), which is the most frequently-utilized methodology in analytics and data science projects. This methodology involves 6 phases of business understanding, data understanding, data preparation, modeling, evaluation and deployment (Chou & Chang, 2022; Silva et al., 2019). Based on this methodology, the research framework of this study is divided into these main phases. The first phase includes investigating the business nature, business needs, and defining objectives. In the second phase, the appropriate data required for analysis is collected and then, in the third phase, is prepared to be used in the modeling phase. In the fourth phase (the modeling phase), the model for achieving the goal defined in the first phase is developed. Following the development of the model, the fifth phase assesses and evaluates the results to confirm the quality of the model. Then, in the sixth phase, the findings are summarized and discussed with the company's decision-makers. The research framework of this study is illustrated in Fig. 1.

ANALYSIS AND RESULTS

Phase 1: Business Needs and Objectives Understanding

The suggested approach in this study is applied to the insurance customer data. First, the demands and objectives of the business are analyzed via interviews with the organization's key decision-makers and studying prior research studies. Most insurance policies are only valid for one year, so retaining low-risk and lucrative customers who generate more profits while posing less risk is imperative (Hamdi & Zamiri, 2016). Therefore, the insurance company needs customer behavior analysis and segmentation in order to identify and retain valuable customer groups with low risk levels as well as mitigate the risk

incurred by high-risk customers. This study aims to adjust the RFM to assess customer behavior by incorporating the loss ratio which is a risk indicator in the insurance industry.



Source: This study.

Figure 1: Research framework

Phase 2 and 3: Data Understanding and Preparation

The second phase includes the selection of the appropriate dataset for inquiry. For the objective of customer behavior analysis and segmentation, four years of data on purchase transactions and loss compensation of 2586 auto body policy customers of an Iranian private insurance company are extracted. In this study, the variables used for analyzing customers are described as the number of months that have been passed from the policy renewal/purchase (R (recency)), the number of renewed/purchased policies (F (frequency)), and the ratio of the losses incurred in claims to the total earned premiums (L (loss ratio)).

To prepare the data for data mining purposes and to ensure that the modeling phase produces effective results, in this step, data collection, integration, cleaning, and transformation are all done as necessary preparation activities. Then, the R (recency) variable is determined using the Max function, F (frequency) is calculated using the Count function, and the Sum function is used to compute the amount of money paid in claims and the amount spent on purchases. Following that, the L (loss ratio) for each customer is determined. Finally, the normalized (standardized) value of each RFL variables are calculated based on the equation (1) for F, as it can positively affect customer value (Monalisa et al., 2019), while equations (2) and (3) are used for R and L, since they negatively impact customer value.

$$F' = (F - F_{min}) / (F_{max} - F_{min}) \quad (1)$$

$$R' = (R_{max} - R) / (R_{max} - R_{min}) \quad (2)$$

$$L' = (L_{max} - L) / (L_{max} - L_{min}) \quad (3)$$

Where R', F', and L' are normalized R, F, and L, and R_{max}, F_{max}, and L_{max} are the highest R, F, and L values, respectively, and R_{min}, F_{min}, and L_{min} are, respectively, the lowest R, F, and L. Using the equations 1, 2, 3, the normalized variables are obtained in order to be used in the modeling phase.

Phase 4: Modeling

In this phase, a model for achieving the objective defined in the first phase is developed by using the K-means clustering algorithm. This algorithm is a partition-based clustering algorithm which has been utilized frequently in different sectors. Initially, in the k-means m points are randomly chosen as the center of clusters, after which each sample is allocated to its closest cluster center. Next, each cluster center is updated to the average of its constituent samples. This process will be repeated until the allocation of samples to clusters remains constant (Qadadeh & Abdallah, 2018).

Clustering using K-means requires the determination of number of clusters. The DBI (Davies-Bouldin index) is employed to this goal, a validity metric defined by the within-cluster cohesiveness and between-cluster separation. Smaller DBI values display the number of clusters closer to optimal (Mohammadzadeh et al., 2017). Accordingly, the ideal number of clusters

within the range of 3-12 is chosen based on the DBI results shown in table 1. Based on the results, the clusters' optimal number is four, with the DBI value at 0.831.

Table 1: Value of Davies-Bouldin index.

Number of clusters	DBI value
3	0.847
4	0.831
5	0.941
6	0.937
7	0.888
8	0.933
9	0.910
10	0.943
11	0.941
12	0.946

Source: This study.

Following that, the K-means clustering algorithm is used to group customers into four clusters, and the mean value of each variable in each cluster is determined. Table 2 illustrates the findings.

Table 2: Means of variables in each cluster.

Cluster.	R	F	L
1.	0.846	0.194	0.836
2.	0.803	0.125	0.377
3.	0.322	0.028	0.309
4.	0.361	0.044	0.763

Source: This study.

As indicated in Table 2, customers in cluster 1 have the highest average R, F, and L variables at 0.846, 0.194, and 0.836, respectively, which are higher than the total means of these variables (total average R: 0.705, total average F:0.139, total average L:0.685). Customers in cluster 3 have the lowest average values of the R at 0.322, F at 0.028, and L at 0.309. Customers in cluster 2 have the second-highest average of R, at 0.803, with the frequency of purchase/renewal at 0.125 and the loss ratio at 0.377, lower than the total means of these variables. Cluster 4 includes customers with a frequency of purchase/renewal, at 0.044, lower than the total mean of this variable that have not made a recent purchase. In addition, this group's 0.763 L variable is greater than the total mean of this variable.

In the next step, the CLV (customer lifetime value) of each cluster, which is the customer profit criterion for the firm, is measured based on the RFL values. To this end, the weights (relative importance) of RFL variables should also be evaluated. Therefore, the weights of these variables as well as the CLV of each cluster are calculated in the following step.

Valuation of weights of RFL variables utilizing Shannon's Entropy

The RFL variables' weights are estimated using the method of Shannon's Entropy. This method has been utilized in different fields as a weighting approach. The procedure of this weighting method consists of four main steps. In the first step, the normalized evaluation index is calculated utilizing equation (4). Following that, the entropy (h_j) is computed based on equation (5). In the third step, d_j , which is the diversification degree, is evaluated using equation (6) for $j= 1, \dots, n$. Finally, the weight and importance degree of the index (W_j) is obtained using equation (7) (Lotfi & Fallahnejad, 2010). Table 3 summarizes the results.

$$P_{ji} = X_{ji} / \sum_j X_{ji} \quad (4)$$

$$h_j = -h_0 \sum_j P_{ji} \ln (P_{ji}) \quad (5)$$

$$d_j = 1 - h_j \quad (6)$$

$$W_j = d_j / \sum_j d_j \quad (7)$$

Table 3: Shannon's Entropy results.

Measure.	W_R	W_F	W_L
h_j	0.964	0.976	0.961
d_j	0.036	0.024	0.039
w_j	0.362	0.244	0.393

Source: This study.

After evaluating the RFL variables' weights utilizing Shannon entropy, the average CLV of cluster (n) is calculated using equation (8):

$$CLV_n = R' * WR + F' * WF + L' * WL \quad (8)$$

Where F', R', and L' are normalized F, R, and L variables using equations (1), (2) and (3), and WF, WR, and WL are, respectively, the weights of F, R, and L obtained using Shannon's Entropy (see Table 3). Finally, the CLV is calculated (Table 4). Since customer segments with higher average CLV values are more valuable than the others, clusters are categorized based on their average CLV.

Table 4: Each cluster's average CLV

Cluster.	CLV
1	0.682
2	0.469
3	0.245
4	0.441

Source: This study.

According to the Table 4, the first cluster in RFL represents the best customers who are low-risk and have the highest average CLV of 0.682. Customers in this group have had a lower loss ratio and a higher frequency of purchase/renewal than customers in the other clusters. Additionally, these customers have recently made a purchase. Customers in the third cluster have an average CLV of 0.245. Not only have these customers been high-risk, but also they have been less active than the other groups. Therefore, they are risky customers. The average CLV of the second cluster is 0.469. Customers in this group have purchased recently and have a lower loss ratio and a higher purchase frequency than those in cluster 3. This group can be categorized as potential customers. The fourth cluster includes customers with an average CLV of 0.441 who have been less active than the second group but have not imposed a significant loss on the company. Therefore, this group contains low-risk but uncertain customers.

Phase 5: Evaluation

The Fifth phase includes evaluating the results of the modeling phase. The ANOVA (Analysis of variance) is performed in this step to assess the distinction of obtained clusters based on the developed RFL model. P-value or Sig (significance level) regarding RFL variables (Recency (F= 2872.446, P-value= 0), Frequency (F= 286.771, P-value= 0), and Loss ratio (F= 2481.417, P-value= 0)) is less than 0.05 (alpha) based on the ANOVA test results (Table 5). Thus, the populations' mean homogeneity is rejected, indicating that the generated clusters using K-means based on the RFL model have different mean values.

Table 5: ANOVA results for RFL model.

Variable Name.	Source of variation	Some of Square	Df	Mean Square	F value	Sig (P-value)
R	Between-group variation	120.796	3	40.265	2872.446	0.000
	Within-group variation	36.194	2582	0.014		
	Total	156.990	2585			
F	Between-group variation	11.365	3	3.788	286.771	0.000
	Within-group variation	34.108	2582	0.013		
	Total	45.473	2585			
L	Between-group variation	116.333	3	38.778	2481.417	0.000
	Within-group variation	40.350	2582	0.016		
	Total	156.683	2585			

Source: This study.

In addition, in order to confirm that mean value of each variable is significantly different in the obtained clusters and clusters are differentiated, comparative analysis based on the post-hoc test (Duncan) is employed. This test analyzes the findings and investigates where the discrepancies between segments occur. According to this test, the placement of the average values in columns demonstrates whether clusters considerably vary in terms of the mean values in each variable or not. If mean values are placed in one sub-group or column, it shows that there is no distinction between them. Based on this test for the RFL variables, there is a significant difference between the mean values of each variable, showing that the clustering results are statistically accurate. In order to make a comparison between RFL and RFM model the results of this test are provided in the followings.

In this study, customers were analyzed based on RFL as the basic RFM model overlooks the risk factor which can be a decisive factor when segmenting customers and ranking them for formulating a company's marketing strategies. In order to show how a risk-adjusted model can result in a better customer segmentation, comparative analysis using ANOVA and post-hoc tests are also used for RFM model. ANOVA result for this model is shown in Table 6.

Table 6: ANOVA results for RFM model.

Variable Name.	Source of variation	Some of Square	Df	Mean Square	F value	Sig (P-value)
R	Between-group variation	136.990	3	45.663	5895.152	0.000
	Within-group variation	20.000	2582	0.008		
	Total	156.990	2585			
F	Between-group variation	29.714	3	9.905	1622.759	0.000
	Within-group variation	15.759	2582	0.006		
	Total	45.473	2585			
M	Between-group variation	5.200	3	1.733	344.076	0.000
	Within-group variation	13.008	2582	0.005		
	Total	18.209	2585			

Source: This study.

Despite the fact that the sig value is less than 0.05 (alpha) based on ANOVA (Table 6), the further analysis using post-hoc test (Duncan) shows no statistically considerable difference in the mean values of the M (monetary value of purchase transactions (premiums)) between clusters 1 and 4 generated based on this model; while the results of this test for the RFL-based clustering demonstrate that the mean values of all RFL variables are significantly different in the obtained clusters (Table 7). Therefore, the results confirm that the L (loss ratio) variable plays a significant role in differentiating clusters.

Table 7: RFL and RFM means differentiation between clusters based on Duncan's test

Cluster number	Model name	Variable name	Cluster Mean			
			1	2	3	4
1	RFL	R	0.846	-	-	-
		F	0.194	-	-	-
		L	0.836	-	-	-
	RFM	R	0.837	-	-	-
		F	0.136	-	-	-
		M	0.039	-	-	-
2	RFL	R	-	0.803	-	-
		F	-	0.125	-	-
		L	-	0.377	-	-
	RFM	R	-	0.207	-	-
		F	-	0.014	-	-
		M	-	0.015	-	-
3	RFL	R	-	-	0.322	-
		F	-	-	0.028	-
		L	-	-	0.309	-
	RFM	R	-	-	0.905	-
		F	-	-	0.417	-
		M	-	-	0.175	-
4	RFL	R	-	-	-	0.361
		F	-	-	-	0.044
		L	-	-	-	0.763
	RFM	R	-	-	-	0.521
		F	-	-	-	0.070
		M	0.034	-	-	-

Source: This study.

Davies Bouldin index (DBI) evaluation also confirmed the superiority of RFL over RFM. According to the DBI evaluation, the DBI value of clustering customers based on RFM is 0.864, while it is 0.831 regarding RFL. Since the lower DBI, the better, RFL performs better than RFM regarding DBI as well.

Phase 6: Deployment

In this phase, results and findings should be summarized. If the results fulfill the major objectives of the business, the suggested framework will be utilized in the business. Based on the primary goal defined in the first phase, business owners need to identify different customer segments in order to develop tailored strategies to effectively deal with customers with high risk levels and unprofitable portfolio while maintaining the low-risk and valuable ones. Accordingly, data from an insurance company for analyzing customer behavior was firstly prepared and provided as inputs for the K-means clustering algorithm, resulting in four clusters. Afterwards, CLV of each cluster was calculated and groups were ranked. Then, ANOVA and post-hoc tests were carried out to ensure the quality of the results. The results and findings of this study are then discussed with the insurance company decision-makers to see whether the outputs meet the primary goals. Based on the interviews, the research has met the business objectives and provided useful information. So, the findings have also been confirmed by the decision-makers.

SUMMARY

With the advancement of information technology and data mining techniques, segmenting and rating customers have become viable for firms. Segmentation is of paramount importance to companies as it can allow them to define target customer groups and analyze their characteristics. One of the most widely-employed models in this regard is recency, frequency and monetary value (RFM). However, this model may not be accurate, especially when it comes to segmenting customers of financial firms and insurance companies that have to deal with miscellaneous expenses and risks related to their customers. In order to maximize their profitability, these organizations need to take into account not only customer profits, but also their risks. In this study, the authors proposed a novel approach named RFL for analyzing customer behavior and clustering by revising the RFM model by replacing the M variable with the loss ratio, an indicator of customer risk in the insurance industry, which is calculated based on the losses incurred in claims as well as the monetary value of purchases (premiums). This risk-adjusted model can provide valuable information for segmenting customers and developing tailored marketing strategies. Accordingly, customers were clustered into four clusters in this study using the Davies Bouldin index (DBI) and the K-means clustering algorithm. Following that, Shannon's Entropy was used for weighting variables, and then the customer lifetime values (CLV) of clusters were computed, allowing for categorizing customer groups with distinct characteristics. According to the results of this study, high-risk and less valuable customers were those with the highest loss ratio and the lowest frequency of purchase who have not made a purchase recently. In contrast, low-risk and valuable ones were those who purchased recently, had the highest frequency of policy purchases/renewals, and had the minimum loss ratio.

By comparing the RFL and RFM, it was also revealed that using RFM in the financial sectors, particularly insurance, that have to deal with customers risk and their imposed expenses would neglect this important dimension, misleading marketers and managers. Therefore, the loss ratio should be taken into account when analyzing and segmenting customers. According to our evaluation, RFL combined with the K-means clustering algorithm can outperform the RFM-based clustering and this risk-based segmentation is more applicable than the traditional RFM in the insurance sector. This approach can provide useful information about various customer groups. Using this approach, behavioral patterns of low-risk and high-risk customers and their buying behavior can be analyzed so as to alleviate the negative impacts of high-risk ones on the company's profitability and increase their profitability via adopting personalized marketing strategies and policies.

In this study, the loss ratio which is an indicator of customer risk in the insurance sector was utilized to adjust the basic RFM model and evaluate customer risk while analyzing their purchasing behavior. Despite having benefits, this study has some limitations that can be addressed in the future studies. First, other variables such as customer demographics (e.g., age, gender, occupation, income) can be taken into account while analyzing customer risk, which we left for future study due to lack of access to such data. Secondly, in the insurance sector as well as other financial industries, customer behavior in the virtual world of the internet as well as features of the services and products might impact customer buying patterns, customer value and also their risk levels. Moreover, in other contexts and sectors, including the banking industry, other risk factors (e.g., credit risk), might be important and influential. Besides, other clustering methods and cluster evaluation indicators can also be used for further studies. Therefore, future research studies can adopt the suggested approach of this study by incorporating other factors and compare their findings to those of this study.

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Sales forecasting of stores in shopping malls: A study based on external data and transaction data

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ABSTRACT

To improve the forecast accuracy of the sales of stores in shopping malls, this paper proposes a prediction method based on deep learning that comprehensively considers the external data, such as online review data of shopping mall stores, weather data, weekday/weekend data, and historical transaction data of the stores. To begin with, the online review data of the stores are pre-trained with BERT (Bidirectional Encoder Representations from Transformers) to complete the multi-label sentiment classification and obtain the intensity index of perceived sentiment of reviews. The index, together with other external data, such as online ratings, weather, weekday/weekend differences, and historical transactions of the stores, is pre-processed. At last, the Long Short-Term Memory (LSTM) and the Attention models are used to predict the sales volume of stores in a certain shopping mall. The results show that the addition of external data – weather, weekday/weekend, online ratings and intensity index of sentiment of reviews – to the historical sales data-based model can effectively improve the forecast accuracy of store sales.

Keywords: BERT pre-training; LSTM Network; sales forecasting; online reviews

INTRODUCTION

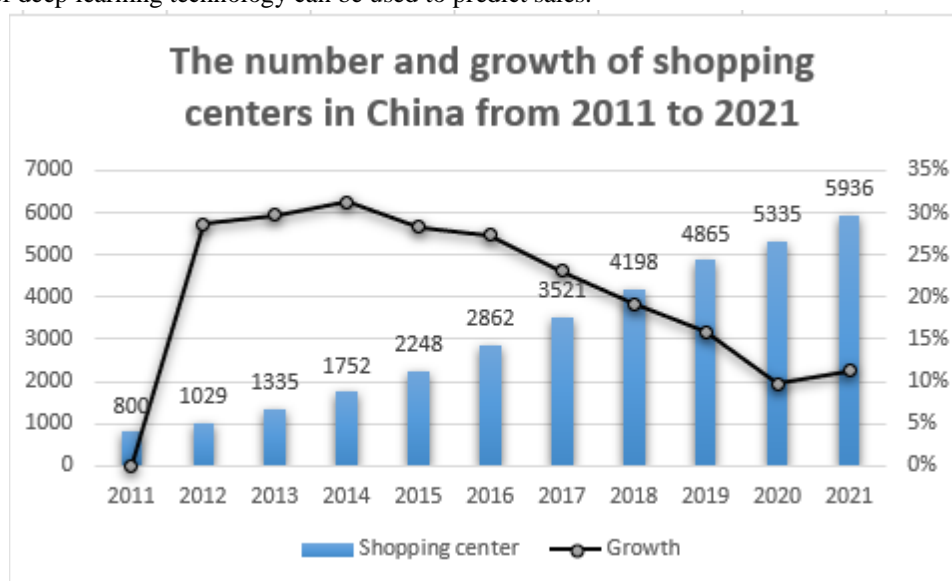
A shopping mall is the space that provides more than three forms of services and businesses, such as supermarkets, department stores, professional stores and exclusive shops, and meanwhile includes more than three combinations of commerce, such as entertainment, catering, offices and residence. These internal components form a collaborative relationship characterized by interconnection and mutual promotion. As China's urbanization rate keeps growing in recent years and urban areas continue to see their land expand and populations grow, shopping malls have become an inseparable part of the urban economy and urban life.

Shopping malls have played an active role in mitigating the negative economic impacts of COVID-19, including stimulating domestic demand, expanding consumption and improving the real economy. However, partly because of the global and domestic economic growth deceleration and the decline in urbanization rate and demographic dividend in recent years, and partly because of the increasing development of online shopping, subsequently, the expansion of bricks-and-mortar shopping malls is slowing down. In first-tier cities in China, the market for shopping malls has reached saturation point. According to Huaon Industry Research Institute (as shown in Figure 1), the average year-on-year growth rate of stock of shopping malls featuring over 30,000 square meters in first- to sixth-tier cities was 28.8% between 2008-2017. In 2018 this figure fell below 20% for the first time, and in 2020 it slid to below 15%. Although their year-on-year growth rate trended upwards in 2021, shopping malls still face the risk of overstocking and need to seek out new prospects for their businesses.

The sign of decline in brick-and-mortar retail is not unique to China. Since 2015, the United States has seen closures of a large number of retail stores. As McArthur *et al.* (2016) and others have wisely proposed, it is important that we try to understand the significant structural differences in the retail sector from the consumer's perspective and make changes accordingly. In this connection, Helm *et al.* (2020) have developed a conceptual framework for retail transformation that, though incomplete, could prepare retailers and public policymakers for changes in the retail environment.

With rapid advancements of technologies, artificial intelligence (AI), big data, cloud computing, etc., have been widely used in the real world and become hot topics in retailing research. For example, Fuentes *et al.* (2017) introduced the AI-enabled interaction into physical retail stores to modify the shopping settings and environment, such as rearranging the location of products displays in the store according to consumers' habits. In terms of the application of big data, the portraits of social

network users (Pan *et al.*, 2019) can be used for precision marketing and product optimization to offer targeted advertisements and recommend products to customers. It not only reduces advertising costs but also expands the scope of business. It can be seen that the use of deep learning technology can be used to predict sales.



Source: Huaon Industry Research Institute (2022).

Figure 1: Number and growth rate of shopping centers in China from 2011 to 2021

Using deep learning for sales forecasting has significant implications for managers in developing business strategies, rationalizing purchases, and controlling operational costs (Singh *et al.*, 2020). Stores are profit-oriented and the sales are the prerequisite for proper operation. When there is excess supply of products, it will lead to excess inventory and slow down the capital flow, which will affect the revenue earned by stores. When the products are in short supply, it can cause negative customer experience and even customer loss, which also affects the revenue. Therefore, sales forecasting is very important to solve these problems and increase sales and drive rapid growth.

This paper comprehensively uses the internal and external data of the stores and the online data from the perspective of consumers, pre-trains the reviews through BERT, and inputs the pre-trained data into the time series models, i.e., LSTM and Attention models, to forecast sales, which provides a reasonable explanation for the results of physical retail sales from multiple perspectives. The empirical study on bricks-and-mortar stores in shopping malls draws a clear conclusion: synthesizing the stores' internal and external data and the online data from the consumers' perspective can yield more accurate results when predicting store sales. These predictions can guide the stores in developing better inventory plans and sales strategies, reduce inventory costs, improve operational efficiency, and seize market opportunities.

In the following section, we review and discuss related works on: (1) sales prediction; (2) the relationship between online reviews and offline sales; and (3) recent technologies that are adopted in this study, i.e., Long Short-Term Memory (LSTM), Attention and BERT. After this, we introduce our data context and propose research methodology. Based on the proposed research framework, we conduct data experiments and provide the results. Finally, we conclude our findings and discuss potentials for future research.

LITERATURE REVIEW

Sales Forecasting

Sales forecasting is of great importance for both business and academic research. A large amount of academic literature has studied the causes that affect sales from different perspectives, and the overall research focus can be divided into two categories: internal and external factors (Tartaglione *et al.*, 2019), and online consumer factors (Martínez-de-Albéniz & Belkaid, 2021). The external factors include weather, weekday/weekend, geographic location, etc. The online consumer perspective includes into online ratings and online reviews.

Impact of Internal and External Factors on Sales Forecasts

Taghizadeh *et al.* (2017) developed robust demand prediction methods for weather sensitive products in retail stores. Their methodology provided the cumulative annual contributions of weather on sales and allowed for deriving the maximum potential annual impact of adverse weather. Using the non-alcoholic beverages as an example, Štulec *et al.* (2019) proposed a design of customized weather derivatives as tools for offsetting failed sales due to adverse weather. Badorf and Hoberg (2020) examined the influence of weather on daily sales in brick-and-mortar retailing using empirical data of 673 stores. Tian *et al.* (2021) analyzed over 6 million transactions made by more than 1.62 million unique consumers at 146 convenience stores in a convenience store chain in China. Their results show that different weather changed the propensity to visit the point of sales because travel cost was affected by weather conditions. In addition, they had different influences on different product

categories, because the reference utility in the mind of the consumer was affected by current weather. Martínez-de-Albéniz and Belkaid (2021) studied the two impact dimensions at a large fashion apparel retailer. Oh *et al.* (2022) examined research directions on the integration of clothing and weather and how weather information was utilized in the clothing industry.

From the above research, it can be seen that the external factors can influence shopping mall store sales. However, it is also obvious that existing literature often focuses on single aspect of the issue and uses relatively traditional methods, leaving the research gaps in retail sales prediction, which this paper intends to address.

The Impact of Online Consumer Perspective on Sales

In the past two decades, online reviews have played an increasingly important role in consumptions. Eslami *et al.* (2018) demonstrated the unique importance of online review positiveness and review score inconsistency in increasing product sales which varied for low and high involvement products. Hu *et al.* (2018) proposed either the impact of reviews had been incorporated into sales or reviews were less truth worthy due to potential review manipulation. As for the design/methodology/approach, Lee *et al.* (2018) used publicly available data from www.naver.com to build a sample of online review data concerning box office. Numerous surveys suggest that consumers often conduct pre-purchase searches not only on the retailer-hosted websites but also on third-party review sites (Wu *et al.* 2018). Ai *et al.* (2019) examined the impacts of online review features on hotel online room sales for various types of hotel segments utilizing a dataset that included 227,378 post-purchase customer review comments for 1,092 hotels. Based on the two-step flow theory, Su *et al.* (2021) explored the impact of online review valence, review volume, and their interactions on online sales. In particular, they focused on the factors that influenced customer purchase decisions and the moderating effect of popular reviews on review valence. From 28 studies focusing on online reviews and sales, Li *et al.* (2020) performed a meta-analysis on the true impacts of six review-related factors, namely, the number of reviews, star ratings, standard deviation of ratings, helpfulness, review length and sentiment, as well as two motivating factors (i.e., price discounts and special shipping) on product sales. In a two-step approach, a measurement model was estimated and a structural model analyzed to test the proposed hypotheses (Ruiz-Mafe *et al.* 2020). Alzate *et al.* (2021) incorporated the notion of review visibility to study the relationship between online reviews and product sales, which was proxied by sales rank information, studying three different cases: (1) when every online review was assumed to have the same probability of being viewed; (2) when Alzate *et al.* (2021) assumed that consumers sorted online reviews by the most helpful mechanism; and (3) when Alzate *et al.* (2021) assumed that consumers sorted online reviews by the most recent mechanism. Yin *et al.* (2021) investigated the impact of online review richness (i.e., reviews containing videos or follow-on reviews) on sales.

In summary, the existing literature on the impact of online rating and review data on sales volume shows that online data have a great impact on product sales. However, most of the existing literature focuses on the impact of online data to online sales, and little uses online data as the basis for studying retail sales of offline physical stores. In particular, there has been no research that combines online rating, sentiment intensity of reviews with the external data of stores. To address these gaps, this paper integrates the data on weather, weekday/weekend differences, and online multi-dimensional sentiment of reviews, to build sales forecast models for offline physical stores. The results show that the gradual addition of weather, weekday/weekend and online multi-dimensional review data can effectively improve the accuracy of offline sales forecast. Meanwhile, making full use of multi-dimensional online data will significantly help improve the accuracy of prediction.

Technological Developments

BERT (Bidirectional Encoder Representations from Transformers) is a pre-training technique used for natural language processing. It contains a two-layer bidirectional Transformer model, unsupervised language representation, and only uses a plain text corpus. BERT solves the problem of massive amounts of data required by NLP models (Devlin *et al.*, 2018). Researchers have developed techniques to train universal language models that use enormous amounts of unannotated text from the Internet as data sources (called “pre-training”). These universal pre-training models can be fine-tuned on smaller task-specific datasets, which can greatly improve the accuracy compared with training on smaller task-specific datasets from scratch.

LSTM is a type of Recurrent Neural Network (RNN). Compared with traditional backpropagation, although standard RNN can utilize time series information, it is prone to the vanishing gradient and the exploding gradient problems during long-distance transmission, which leads to the inability of neural network to train weights in the process of backpropagation, and makes it difficult for RNN to learn long-distance information. To tackle this problem, Hochreiter and Schmidhuber (1997) introduced the Long Short-Term Memory (LSTM) method, which controls the flow of information and avoids long-term dependency problems by adding the cell and three gates: the input gate, the forget gate, and the output gate. The forget gate decides if we want to dispose of a piece of information, the input gate decides the update of information, and the output gate decides what output to generate from the current cell state. The gate structures are used for storing important information and forgetting unnecessary information to improve memory for long time sequences.

Pan *et al.* (2018) proposed a LSTM-based model to cope with airlines’ needs for daily demand forecasting. Helmini *et al.* (2019) showed that deep learning models (e.g. recurrent neural networks) could provide higher accuracy in predictions compared to machine learning models due to their ability to persist information and identify temporal relationships. Shih *et al.* (2019) proposed a model to forecast short-term goods demand in e-commerce context. Weng *et al.* (2019) designed a model that could accurately forecast the supply chain sales. Goel *et al.* (2020) used different noise distributions, such as normalized,

uniform, and logistic distributions to prove that sales forecasting research had very important value for strategic decisions and improvement measures made by enterprises. Pliszczyk *et al.* (2021) developed an algorithm for forecasting sales in the supply chain based on the LSTM network using historical sales data of a furniture industry company. They also found that the main challenges of the forecasting task were the high-dimensional influence variables with noise and the complex time series relationships. Zhao *et al.* (2021) proposed a DAE-LSTM algorithm combined with denoising autoencoder (DAE) and long short-term memory (LSTM) to deal with this problem. Based on real sales data, Li *et al.* (2022) constructed LGBM and LSTM sales prediction models to compare and verify the performance of the proposed models. Other influential work includes Han's (2020).

In 2014, a research team from Google proposed the Attention mechanism (Mnih *et al.* 2014) that is better at capturing the internal correlation of data or features. It changes the traditional encoder-decoder structure. The traditional decoder gives the same weight to each input, but in reality different inputs often have different importance. During the process of decoding, Attention uses the scoring function to calculate the influence of different inputs on the predicted value and gives them different weights to solve this problem. In essence, the Attention model calculates the difference between the current input sequence and the output vectors, and the smaller the difference is, the higher weight Attention should assign here.

In summary, the existing studies mainly focus on the impact of internal and external factors on bricks-and-mortar store sales and the impact of online review data on online stores. Gaps remain in terms of sales forecasting of physical stores in shopping malls. This paper comprehensively considers the weather, weekday/weekend, online ratings and sentiment intensity of reviews, using BERT, LSTM and Attention, to improve the forecast accuracy of the sales of stores.

DATA SOURCES AND METHODOLOGY

Data Sources

Stores data

A total of 45,692,624 data from physical stores in a certain shopping mall from January 2017 to March 2019 are selected for this research. Bound by the relevant cooperation agreement that the disclosures of data on store names and sales volume shall not be allowed, the actual store names are replaced by Store A and Store B. In this conference paper, we select two representative brick-and-mortar stores in City A to conduct the sales forecasting study.

Weather data

The weather data selected in this paper are weather conditions withdrawn from the website <https://www.lishi.tianqi.com/> by using a Python web crawler. The Historical Weather Channel (<https://www.lishi.tianqi.com>) provides historical weather forecasts for 2290 areas belonging to 34 provinces and cities across China, with data from the China Meteorological Administration for the day in which the city is located. To make the sales forecasting results more accurate, over ten weather conditions are divided into four major categories: sunny, cloudy, rainy and snowy. The number of days for the above four weather conditions is counted.

Online rating and review data

The online rating and review data in this paper are extracted from the shopping mall stores registered in Dianping, China's leading local lifestyle information and trading platform, using a Python web crawler. In line with the rating scale used in Dianping, the online rating data are divided into four categories: overall rating, food rating, environment rating, and service rating. Online reviews are divided into seven categories according to the importance of the reviews: location, attitude in customer service, store environment, price level, taste, overall evaluation, and customer flow.

Pre-processing of data

In terms of the internal data of the shopping mall, the historical transaction data of the shopping mall are first pre-processed. Since the raw dataset is messy and contains outliers and missing values, we first Extract, transform, and load (ETL) the data so as to obtain a complete and correctly sorted dataset. In terms of the external dataset, we collect the daily weather conditions corresponding to the daily sales of the shopping mall, and after counting the days of different weather conditions, we have the historical weather dataset. Finally, after indexing and saving the time, location and internal data, we attain the complete input data for the LSTM model, and the structure of their features are shown in Table 1.

Table 1: Structure of the features of input data

Symbol	Meaning	Measurement
X_1	Sales hours	Daily sales hours
X_2	Weekend	Dummy: no: 0, yes: 1
X_3	Weekday	Dummy: no: 0, yes: 1
X_4	Sunny	Dummy: no: 0, yes: 1
X_5	Cloudy	Dummy: no: 0, yes: 1
X_6	Rainy	Dummy: no: 0, yes: 1
X_7	Snowy	Dummy: no: 0, yes: 1

X_8	Overall rating	Rating scale: 1-5 (1 for the lowest rating, 5 for the highest rating)
X_9	Environment rating	Rating scale: 1-5 (1 for the lowest rating, 5 for the highest rating)
X_{10}	Food rating	Rating scale: 1-5 (1 for the lowest rating, 5 for the highest rating)
X_{11}	Service rating	Rating scale: 1-5 (1 for the lowest rating, 5 for the highest rating)
X_{12}	Location	Rating scale: 1-5 (1 for the lowest rating, 5 for the highest rating)
X_{13}	Attitude in customer service	Sentiment intensity: 1-3 (1 for negative, 2 for neutral, 3 for positive)
X_{14}	Store environment	Sentiment intensity: 1-3 (1 for negative, 2 for neutral, 3 for positive)
X_{15}	Price level	Sentiment intensity: 1-3 (1 for negative, 2 for neutral, 3 for positive)
X_{16}	Taste	Sentiment intensity: 1-3 (1 for negative, 2 for neutral, 3 for positive)
X_{17}	Overall evaluation	Sentiment intensity: 1-3 (1 for negative, 2 for neutral, 3 for positive)
X_{18}	Customer flow	Sentiment intensity: 1-3 (1 for negative, 2 for neutral, 3 for positive)
X_{19}	Service rating	Sentiment intensity: 1-3 (1 for negative, 2 for neutral, 3 for positive)
X_{20}	Sales volume	Daily sales, by yuan

Methodology

BERT

Sentiment Analysis (SA), also known as opinion mining and viewpoint mining, is the use of information extraction, text mining, machine learning, natural language processing, and other text processing technologies to analyze, process and summarize subjective texts. It involves text classification, viewpoint analysis, tendency analysis, and many other methods, and is used to analyze people's opinions, feelings, evaluations, attitudes, and emotions regarding entities and their attributes. The sentiment analysis that uses Word2Vec ignores the context of words when calculating their similarity, while the BERT model displays outstanding accuracy when conducting sentiment analysis of the reviews. Therefore, currently, BERT is often used for classification in sentiment analysis.

The BERT model first obtains the word vectors containing the context and semantics information by pre-training, and introduces the Attention mechanism to extract text information, assign weights, and highlight the key information for text sentiment classification. The ternary sentiment classification of the reviews includes negative, neutral, and positive. The processes of sentiment analysis with the BERT model include:

- 1) Loading the pre-trained BERT model;
- 2) Input of features to the BERT model.

Attention-LSTM

We input the historical time series data (X_1, X_2, \dots, X_n) to learn the features, and fit the highest daily sales on day $n+k$. Figure 2 shows the overall structure of the AM-LSTM model for sales prediction, including four parts: data pre-processing, the LSTM layer, the Attention layer, and the fully connected layer.

- 1) Data pre-processing, i.e., all input data are processed into the structure as shown in Table I, and normalized;
- 2) The LSTM layer uses the deep features of the input time series data after pre-processing, to learn the long-term dependencies of the time series data;
- 3) The Attention layer first encodes the data through the Encoder, then calculates the corresponding weights for the encoded vectors by Attention. The calculated weights are used to weight the encoded vectors and as the input to the Decoder, and finally gets the output through the Decoder;
- 4) The fully connected layer calculates the input to this layer and gets the sales forecast result. The predicted sales are subtracted from the real sales to return the loss function, and the weights and forecast result are continuously modified by backpropagation of the loss function.

Framework of Sales Forecasting of Stores in the Shopping Mall based on External Data and Transaction Data

Figure 2 illustrates the framework of sales forecasting of stores in the shopping mall based on external data and transaction data. The framework includes processing of sentiment intensity of reviews, input data processing, the LSTM model, the Attention layer, and specific applications of the fully connected layer, and finally obtains sales forecasts.

- 1) Crawl the review data of physical stores from online, and load the review contents to the pre-trained BERT model, and input the BERT model features;
- 2) Crawl the rating scores of physical stores from online, pre-process the data on weather, weekday/weekend, store sales, and the already processed sentiment intensity of reviews, meanwhile fill in the missing values and conduct other necessary operations. All the final features are shown in Table 1;
- 3) Input the historical time series data (X_1, X_2, \dots, X_n) into the LSTM model to learn the features. Through the training in the LSTM layer, the long-term relationship of time series data can be learned more fully;
- 4) The output of the LSTM layer is used as the input to the Attention layer, which is first encoded by the Encoder, and the corresponding weights of the encoded vectors are calculated by Attention. The calculated weights are then used to weight the encoded vectors, which will be the input to the Decoder, and finally the output is obtained by the Decoder. Through continuous learning, the corresponding weights are optimized, the key information in the input features is highlighted, the nonlinear characteristics between variables are further explored in depth. The higher the score, the higher the attention, and the Attention mechanism will assign more weight to it;
- 5) The output of the Attention layer is used as the input to the fully connected layer. The fully connected layer calculates the input to obtain the sales forecast result. The predicted sales are subtracted from the real sales to return the loss function, and the weights and prediction results are continuously modified by backpropagation of the loss function.

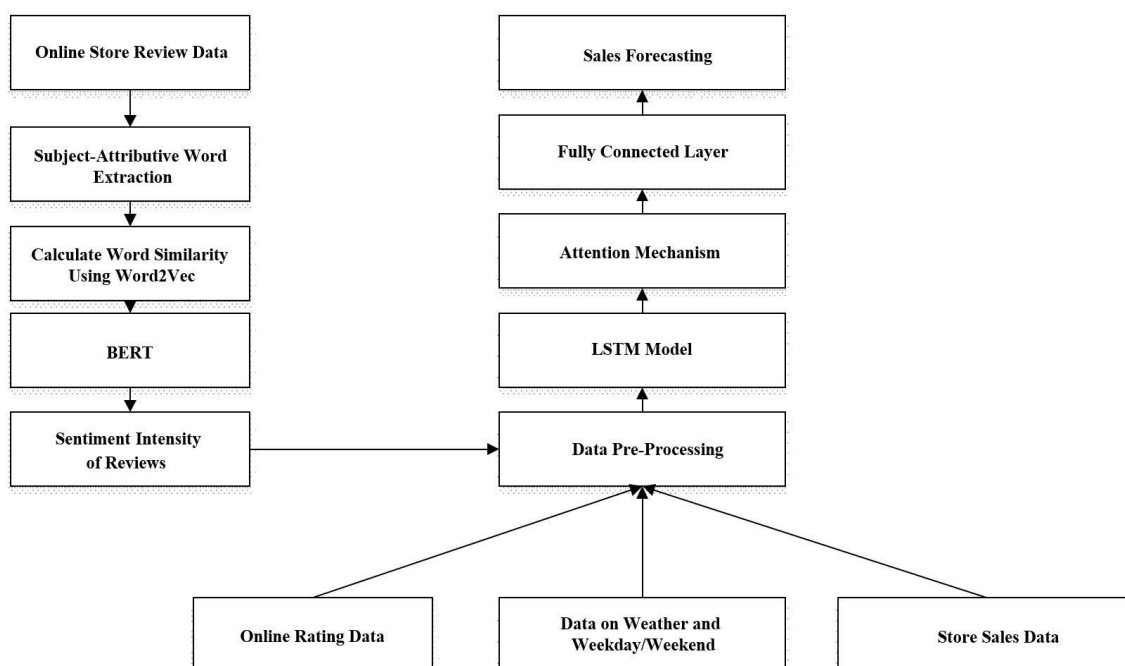


Figure 2: Framework of Sales Forecasting of Stores in the Shopping Mall based on External Data and Transaction Data

EXPERIENTS AND RESULTS

Performance Metrics

This paper uses the Root Mean Square Error (RMSE), as in equation (12), and the Mean Absolute Percentage Error (MAPE), as in equation (13), which are commonly used in time series forecasting, as the metrics for the model. They are used to measure the difference between the predicted value and the actual value. The lower the RMSE and MAPE, the closer the predicted value is to the actual value, and the better the model is. RMSE and MAPE are calculated as:

$$RMSE = \sqrt{\frac{1}{T} \sum_{t=1}^T (y'_t - y_t)^2} \quad (12)$$

$$MAPE = \frac{100\%}{T} \sum_{t=1}^T \left| \frac{y'_t - y_t}{y_t} \right| \quad (13)$$

Where y'_t represents the predicted value on day t , and y_t represents the actual value on day t .

Case Verification

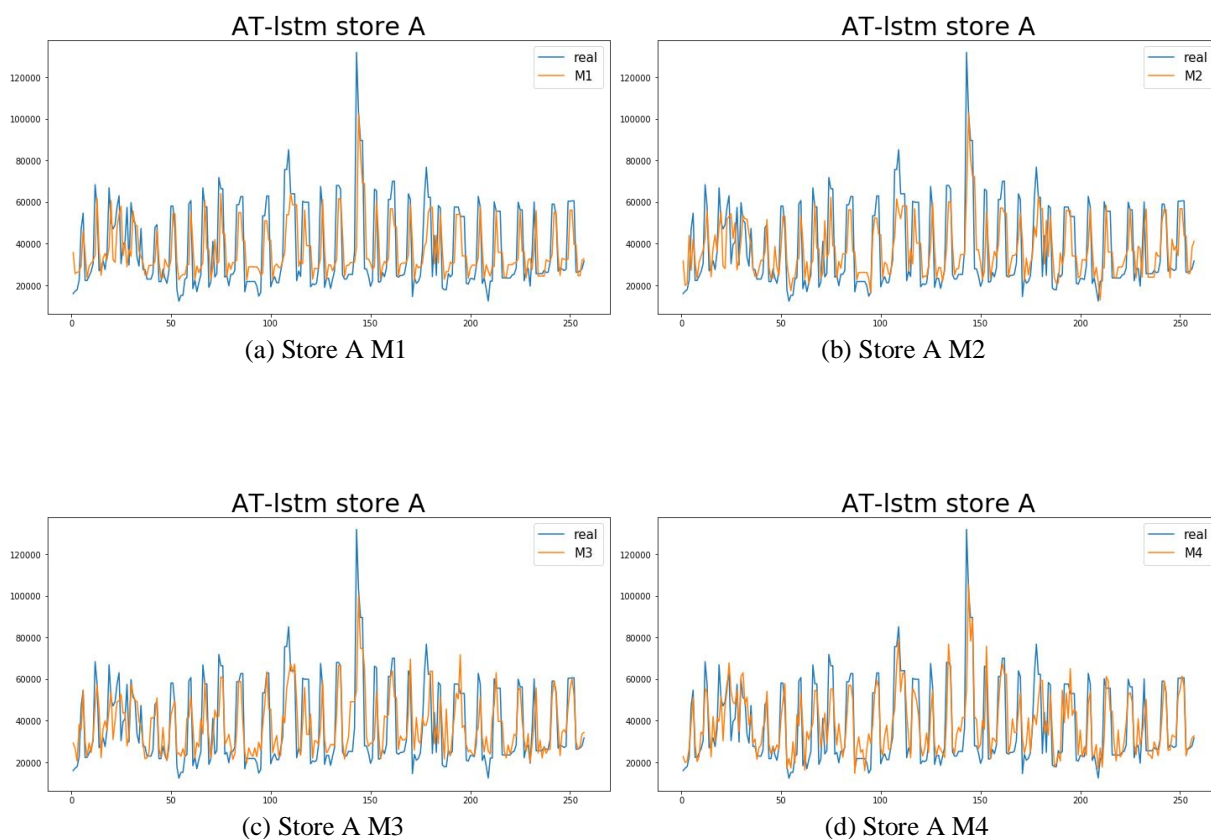
To verify that the addition of each metric improves the forecast accuracy of the model, this paper constructs four models for comparative analysis: (1) Model 1 (M1) that only has sales hours and weekday/weekend as metrics; (2) Model 2 (M2) with sales hours, weekday/weekend and weather; (3) Model 3 (M3) with sales hours, weekday/weekend, weather and ratings; and (4)

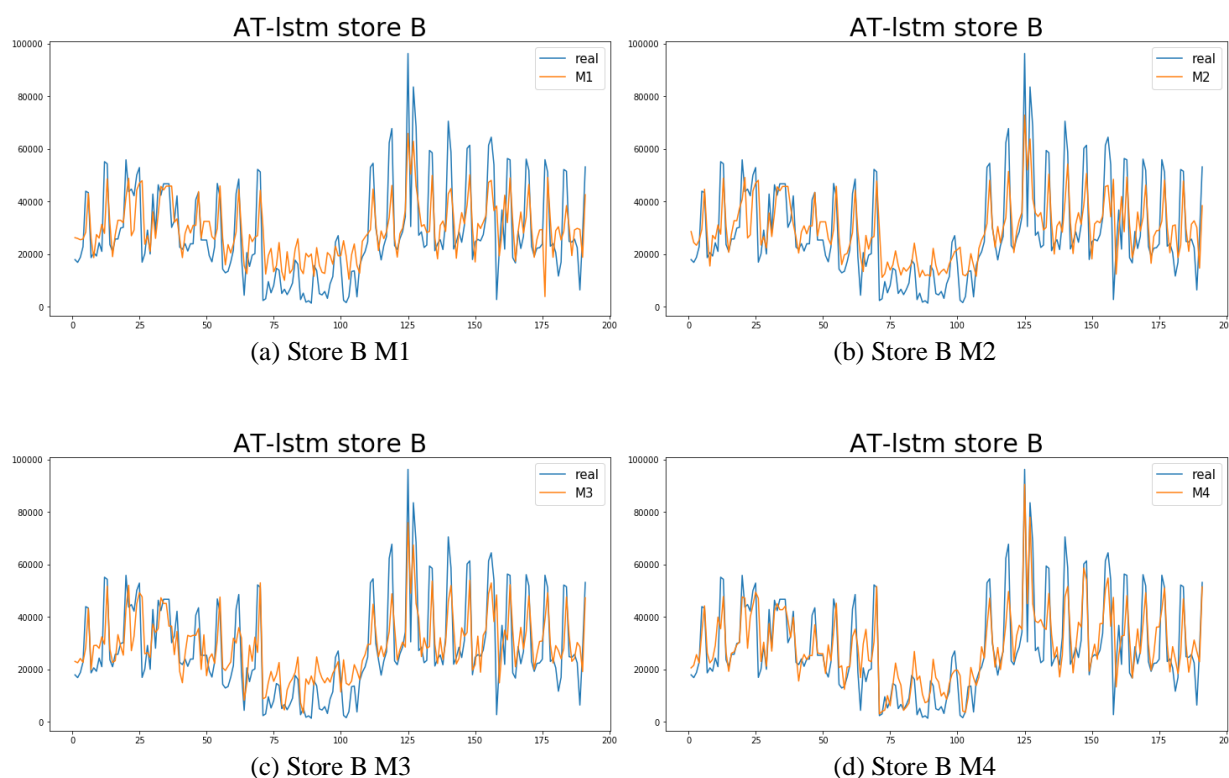
Model 4 with sales hours, weekday/weekend, weather, ratings and perceived sentiment of reviews. The forecasting results for the 2 brick-and-mortar stores are shown in Table 2. Compared with M1 that only considers the historical weekday/weekend sales, the MAPE and RMSE for the 2 stores' sales forecasts are significantly lower in M2 with the addition of the weather variable. Similarly, compared to M1, M3 with the addition of the online ratings variable demonstrates improved forecast accuracy. The forecast accuracy of M4 is further enhanced with the addition of online ratings and perceived sentiment of reviews. Also, compared with M1, the MAPE of Store A, which has the best forecast result, decreases from 32% to 23%, and the RMSE decreases from 15305.9 to 13019.5. The MAPE of Store B also declines by about 8% and RMSE by about 2,000.

Table 2: Model evaluation results of Store A and Store B

Model	Metrics	Store A		Store B	
		MAPE	RMSE	MAPE	RMSE
M1	Sales hours and weekday/weekend	32	15305.9	42	15083.4
M2	Sales weekday/weekend, hours, and weather	28	14497.5	39	14629.1
M3	Sales weekday/weekend, hours, weather and ratings	27	14265.3	37	13937.9
M4	Sales weekday/weekend, hours, weather, ratings and perceived sentiment of reviews	23	13019.5	34	13038.2

Figure 3: Comparison of the model evaluation results





With the above results, we find that simultaneously using multi-dimensional inputs, such as sales hours, weekday/weekend, weather, online ratings and perceived sentiment of reviews, can substantially improve the accuracy of sales forecasting of bricks-and-mortar stores. The reason is that the integration of the consumers' perspective can reflect the overall store sales more accurately. The features of the consumers' reviews often contain the attendant's attitude, the overall environment of the store, and the customer flow on that day, all of which can improve the accuracy of the forecast. Store managers can also take these perspectives to improve the store's service and environment to enhance competitiveness and increase customer stickiness.

CONCLUSION

In the post-pandemic era where online shopping is surging, bricks-and-mortar stores in shopping malls seem to be lacking momentum. For these offline stores, it is of far-reaching significance to improve sales forecasting accuracy from multiple perspectives, thereby enhancing operational efficiency, increasing revenue and competitiveness. In this paper, we consider multiple data such as weather, weekday/weekend, online ratings and reviews and sentiment intensity to improve sales forecasting accuracy for physical stores. For stores, the improved sales forecasts can help them develop reasonable business strategies and purchasing arrangements, improve operational efficiency while avoiding the risk of overstocking, optimize services and increase profits. For consumers, online reviews can help them form a more comprehensive understanding of the products and make better-informed purchasing decisions, meanwhile, the improved customer service can bring them better in-store shopping experience. For online platforms, the findings can facilitate the use of the platform and contribute to a better platform experience. Specifically, this study has the following theoretical and managerial implications

Theoretical Implications

Unlike existing sales forecasting studies that focus on the impact of online reviews on online store sales (Eslami et al., 2018), this paper integrates the impact of weather, weekday/weekend, online ratings and reviews on bricks-and-mortar stores, which provides new insights into the sales forecasting of stores. The methodological innovation of this paper is that it considers multiple data — online and offline, such as online reviews and offline sales, and internal and external, such as historical transactions and weather — when trying to improve the accuracy of the sales forecasts. In addition, by mining text reviews with the BERT model, the reviewer's (consumer's) sentiment towards products is extracted, and the impact of reviews on sales is examined. The innovative evaluation of the role of different review information in increasing sales will be useful for targeted marketing campaigns, user-centered product design, and effective customer service in the future. What's more, this paper uses the Attention mechanism and LSTM model (Hochreiter & Schmidhuber, 1997) based algorithms to deep learn the features of the data from the stores in a certain shopping mall, optimizes and configures the model parameters, and conducts simulation experiments with the models. The simulation results show that the predicted sales of the stores using the deep learning Attention mechanism and LSTM only have very small errors, indicating that the model can be used to predict the sales of the shopping mall stores. And it presents a strong validation and solution idea for subsequent theoretical research on multi-perspective shop sales forecasting.

Managerial Implications

Since both the weather and weekday/weekend differences have an impact on sales, stores should be circumspect when making business plans, and maintain a good indoor environment to attract potential customers even during adverse weather. When the weather is good, and customer flow increases on weekends, stores should try to maintain a good attitude in service and improve efficiency to reduce customer waiting time and provide courteous and attentive service. When the research framework and forecasting project goes live it will solve the problem of high cost of goods inventory that exists in the business, the overall number of days of goods turnover in shops will drop, and the cost of warehouse and space will be greatly reduced

From the perspective of online reviews and rating data, both variables have a significant positive impact on customers' purchase decisions. Potential customers consider the overall rating score of a store and the textual information of the reviews to decide they want to choose that store for their purchases. Therefore, merchants and brand owners should continue to optimize the quality of their products and services, including improving the service provided by attendants. They should also pay attention to online reviews and make improvements to address the issues and complaints raised by customers. Further, the stores can encourage customers to give real and objective comments on the food, services, environment, pricing, for the stores to improve management. Finally, to adapt to the needs of consumers of various income classes, the stores may consider lowering the price or increasing the portion size as appropriate to provide cost-effective products.

Limitations

Since only two stores are selected for sales forecasting in this paper, the data are insufficient compared to the massive amounts of data nationwide. Follow-up research can consider increasing the sales data of bricks-and-mortar stores for forecasting experiments. In addition, the stores data in the current study are all from the restaurant industry, which is limited for comparative studies. Future research can consider adding other types of physical stores, such as clothing and outdoor gears stores, and changing the corresponding evaluation metrics in the reviews data BERT pre-training, it is possible to extend the research framework to other categories in other offline retail sectors to enrich the research landscape of sales forecasting of stores in shopping malls.

ACKNOWLEDGEMENTS

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Smart home on the rise? The role of trust and privacy in technology acceptance of smart home devices

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ABSTRACT

In recent years, smart devices have been more prevalent in people's homes. In this context, this study analyzes the role of trust and privacy in technology acceptance of those devices. Derived from theoretical considerations, we form eleven hypotheses and test them by structural equation modeling (SEM). The analysis relies on data from a quantitative survey on smart thermostats with 324 participants from Germany. The results indicate a strong positive total effect of trust and a negative impact of privacy concerns on the intention to use, showing the special relationships of those factors in the context of smart home technology.

Keywords: Smart home, technology acceptance, trust, privacy.

INTRODUCTION

In the past, only people were smart, today things are too. Over the past few years, the word 'smart' has become an umbrella term for all innovative technologies that are based in some form on artificial intelligence. The main feature of these smart technologies is their ability to capture information from the environment and to react to it independently (Marikyan et al., 2019). Thanks to the multitude of resulting advantages for everyday life, such technologies quickly found their way into the homes of many people. There, they are gradually making the innovative smart home concept a reality (Darby, 2018). There is already a smart alternative to almost every conventional household item. The market for smart home devices is booming and growing steadily. According to Statista (2021), the volume of the German smart home market will grow from around €5,407 million in 2021 to €9,259 million in 2026. This corresponds to an annual sales growth of 11.36%. The German smart home market is becoming more and more lucrative for manufacturers and the potential is far from exhausted. According to a representative survey by Splendid Research (2020), only 40% of Germans use smart home devices at all. In addition, very few of them (18%) actually connect several devices to form a smart home system. At least 38% of Germans are interested in using it, while 22% still categorically reject it. One of the most frequently mentioned concerns in connection with smart home devices, apart from the high acquisition costs (52%), is the concern for privacy (45%). In contrast to users in the USA or Great Britain, German users take a critical view of the subject of data protection in smart homes. They do not want to disclose their personal data and are very concerned about misuse (Infratest dimap, 2020).

The acceptance of smart home devices is a basic requirement for their market success. Lately, the speed at which these technologies get accepted is additionally driven by the COVID-19 pandemic. Since its beginning, the amount of time people are working, studying, and socializing at home has highly increased, especially during lockdown times. This development results in even more home upgrades using smart home devices. However, its rapidity also has implications for thoroughly thinking through any potential risks that come with these devices. The more this technology is accepted, the more insights into private life and the data generated will be given. Hence, a lot of trust in smart home devices is required (Maalsen & Dowling, 2020).

In the field of acceptance research, various impact models for the general prediction of technology acceptance have already been developed and checked. Some of these models are already being used in the context of smart home devices as well. However, trust and privacy concerns have been rarely taken into account yet. This paper aims to meet this research need and to make a decisive contribution to technology acceptance research in the field of smart home devices. Consequently, we come to the following research question:

What role do trust and privacy concerns play in the technology acceptance of smart home devices in Germany in addition to its main drivers?

To answer this research question, we form hypotheses based on an extensive literature research and conduct a quantitative survey study – the resulting data from the survey is analyzed by structural equation modeling (SEM).

The remainder of this paper is structured as follows: After this introduction, we present related work, based upon which we will derive hypotheses resulting in our conceptual model. Subsequently, we introduce our methodology and structure of the empirical study, before we present the statistical results. Finally, we discuss those results and conclude the paper.

RELATED WORK

This section covers related work addressing the acceptance of innovative technologies, including smart home devices.

The theory of reasoned action (TRA; Ajzen & Fishbein, 1970, 1973; Fishbein & Ajzen, 1975) and the theory of planned behavior (TPB; Ajzen, 2005) form the basis for various sub-areas of acceptance research and thus also for that of technology acceptance. According to Schäfer and Keppler (2013), this includes various research strands that deal with such different aspects as the individual user acceptance of larger and smaller technical artifacts (e.g. mobile phones, office technology, software), through to the social acceptance of new and/or risky technologies (e.g. nuclear energy, genetic engineering). Based upon these theories, the seminal technology acceptance model (TAM; Davis 1986; Davis et al. 1989) was developed which specifically deals with the prediction of the acceptance of primarily new technologies and systems (see Figure 1). As opposed to the TRA and the TPB, it only considers the attitudinal component of behavioral intention (Davis, 1986). Based on the perceived innovation characteristics according to Rogers (1983), attitude toward using in the context of the TAM consists of two main behavioral beliefs: perceived usefulness as “the degree to which an individual believes that using a particular system would enhance his or her job performance” (Davis, 1986, p. 26) and perceived ease of use as “the degree to which an individual believes that using a particular system would be free of physical and mental effort” (Davis, 1986, p. 26). The predictive power of the TAM has been shown significantly with the help of data from 107 surveys of full-time MBA students in the USA on their voluntary use of a word processing program (Davis et al., 1989). Over the years, the TAM has been enhanced several times. In 2000, the TAM2 was presented (Venkatesh & Davis, 2000) and the TAM3 in 2008 (Venkatesh & Bala, 2008). In both cases, the researchers looked at the factors behind each of the two main behavioral beliefs in more detail. In addition, other functional and hedonic antecedents of behavioral intention were examined and recorded in the context of their unified theory of acceptance and use of technology (UTAUT; Venkatesh et al., 2003) and its extension (UTAUT2; Venkatesh et al., 2012).

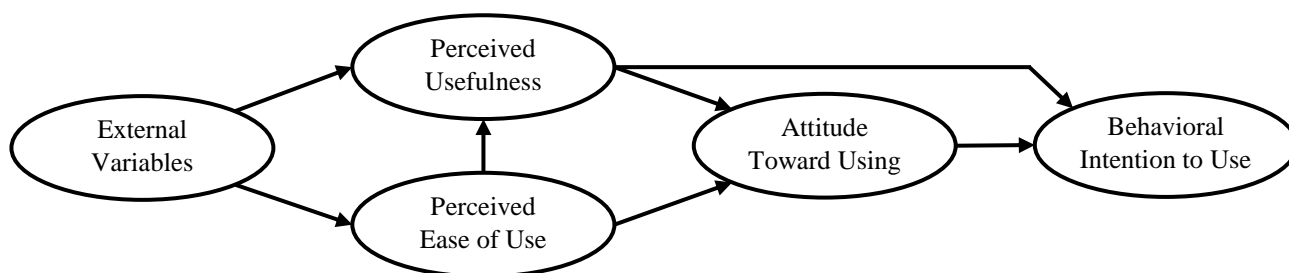


Figure 1: Technology Acceptance Model (after Davis et al., 1989)

When researching the acceptance of innovative technologies, it must be borne in mind that, in addition to their relative advantages over unintelligent or less intelligent devices, they can always entail various risks (Mani & Chouk, 2018). According to the prospect theory of Kahneman and Tversky (1979), possible losses are perceived more clearly than possible gains. The negativity bias theory similarly explains that people give more weight to negative information than comparable positive information when evaluating contexts, objects, or other people (Ito et al., 1998). Therefore, Cenfetelli (2004) recommends taking a person's perceived advantages as well as their inhibitions into account when adopting a technology using a two-factor approach.

Concerns about data privacy that are related to trust building can be understood as an inhibiting factor in technology acceptance. It is demonstrated by McKnight et al. (2011) that a person's trusting beliefs directly result in forming an intention to explore and make deep use of a technology. They concluded this from a survey with 359 MIS students in the USA on their use of the Microsoft Access and Excel programs. Furthermore, Wirtz et al. (2018) emphasize the important role of trust using the example of the acceptance of service robots in their service robot acceptance model, which they developed based on a literature review. Liu et al. (2005) include privacy as a factor of trust in their technology acceptance model: Using the example of an online bookstore, they demonstrated the decisive role of privacy in an experiment and a survey of 258 students and graduates in the USA. Dinev and Hart (2006) use their Extended Privacy Calculus Model to show that in the e-commerce sector, internet privacy concerns have a negative impact on willingness to transact on the internet with data from 369 respondents. Zhou (2011) is able to demonstrate the effects of privacy concerns and trust in the acceptance of location-based services based on a survey of 210 mobile users in China. In the area of social networking services, similar effects are significantly demonstrated by Chang et al. (2017). For this, they conducted twelve interviews with IT & e-commerce experts as well as industry consultants and evaluated a survey of 168 experienced Facebook and LinkedIn users.

With the spread of the smart home concept, respective technologies moved further into the application area of technology acceptance research. Smart home devices represent intelligent devices for the home that can be connected to other devices in a

centrally controlled communication network in order to be able to independently fulfill tasks in their function as actuators in response to information from sensors or applications integrated into that network (Balta-Ozkan et al., 2014). In a broader sense, stationary voice assistants can also be viewed as smart home devices. However, they do not fall under the definition used in this paper, since their smart home connection is primarily limited to the control of the actual smart home devices, as is the case with smartphones, smartwatches, and tablets. Concerning technology acceptance, Park et al. (2017) significantly demonstrate all assumptions of the TAM in the acceptance of IoT technologies in the smart home domain based on a survey of 1,057 smart home users. Tereschenko (2020) addresses the acceptance of AI-driven smart home devices by means of an experiment and a survey of 126 people. This work shows that initial trust beliefs play a key role in adoption intention using vacuum robots as an example. Pitardi and Marriott (2020) develop a more comprehensive model for building technology acceptance and trust in the smart home sector, including privacy. Using the example of AI voice assistants, they surveyed 466 users. As a result, they can confirm the hypotheses of the TAM as well, but not the influence of privacy on trust and, thus, the acceptance process. As a result of twelve subsequent in-depth interviews, they are able to explain this result from the fact that privacy concerns are more likely to be directed at the manufacturer or software operator than at the device used. The study by Marikyan et al. (2021) on the acceptance of smart home devices in general shows similar results. After evaluating a survey of 422 current and former smart home users, they are able to confirm the hypotheses of the TAM, as well. However, like Pitardi and Marriott (2020), they do not find any significant influence of privacy on the acceptance process.

As collated above and to our best knowledge, only a few models with regard to technology acceptance have been analyzed in the context of smart home devices. Moreover, mostly, only factors in favor of using the technology are addressed disregarding factors for rejecting it—especially privacy concerns are rarely addressed. Therefore, this paper aims to meet this research need and to make a decisive contribution to technology acceptance research in the domain of smart home technologies.

CONCEPTUAL MODEL

In the field of acceptance research, various impact models for the general prediction of technology acceptance have already been developed and checked as shown above. Among these models, the TAM (Davis, 1986; Davis et al. 1989) is considered one of the most prevalent approaches since a vast number of studies have already confirmed and validated the model. In order to test the main drivers of the technology acceptance of smart home devices, the hypotheses of the TAM (see Figure 1) are also adapted in this study:

- H1: *Attitude toward using smart home devices has a positive impact on the behavioral intention to use them.*
- H2: *Perceived usefulness of smart home devices has a positive impact on the behavioral intention to use them.*
- H3: *Perceived usefulness of smart home devices has a positive impact on the attitude toward using them.*
- H4: *Perceived ease of use of smart home devices has a positive impact on the attitude toward using them.*
- H5: *Perceived ease of use of smart home devices has a positive impact on their perceived usefulness.*

As in the TAM, the *behavioral intention to use* in the hypotheses of this paper is understood, based on Fishbein and Ajzen (1975), as the subjective probability of a person that it will perform a certain behavior (here: the use of smart home devices). Accordingly, the *attitude toward using* represents the general feeling of a person that the use of a certain technology (here: smart home devices) is advantageous or disadvantageous. The definitions of the two core beliefs of the attitude toward using follow Davis' (1989) definition. *Perceived usefulness* describes the degree to which a person believes that a certain technology is useful in their everyday life, and *perceived ease of use* describes the degree to which that person believes that using this technology is effortless.

The model extensions of TAM2 and TAM3 are not considered in the hypotheses of this paper. The subjective norm is explicitly not included as a variable, as it only has a significant influence on the behavioral intention to use if the use of the technology under consideration is mandatory in the specific context (Lai, 2017; Olbrecht, 2010). This does not apply to the use of smart home devices in a private context. Furthermore, the addition of additional factors from TAM2 and TAM3 would increase the complexity of the research model, which might not lead to any significant advantages compared to the original TAM (Agudo-Peregrina et al., 2014).

In addition to the determinants of use, perceived usefulness and perceived ease of use, trust in the technology also plays a demonstrably decisive role (Warkentin et al., 2017). According to the literature, it is understood as a strong determinant of technology adoption (McKnight et al., 2011; Wirtz et al., 2018). Based on the confirming findings by Wu et al. (2011), the following additional hypotheses are added to the hypotheses H1 to H5 listed above:

- H6: *Existing trust in smart home devices has a positive impact on the behavioral intention to use them.*
- H7: *Existing trust in smart home devices has a positive impact on the attitude toward using them.*
- H8: *Existing trust in smart home devices has a positive impact on their perceived ease of use.*
- H9: *Existing trust in smart home devices has a positive impact on their perceived usefulness.*

Trust can be built on a (quasi) interpersonal or systemic level (Lankton et al., 2015). (Quasi) interpersonal trust plays a role when technologies are perceived by users as human-like due to their appearance, their movement, their behavior or possibly even the emotions they express and are therefore humanized (Zlotowski et al., 2014). Since smart home devices have so far

hardly had any human-like features, users primarily encounter them with system-related trust (Tereschenko, 2020). A corresponding level of trust is therefore also meant in the hypotheses of this paper. Following the understanding of McKnight et al. (2011) it refers to beliefs that a given technology can perform required tasks (functionality), adequately support one in its use (helpfulness), and function consistently and predictably (reliability).

As recommended by Cenfetelli (2004) in connection with the acceptance of innovative technologies, the research model of this paper follows a two-factor approach. In addition to the introduced driving factors, privacy concerns are covered as an inhibiting factor. This is intended to enable a more holistic view of the technology acceptance of smart home devices. As discovered in prior research, privacy concerns negatively influence trust (Chang et al., 2017; Liu et al., 2005; Zhou, 2011). The combined influences of privacy concerns and trust as extensions of the TAM have only been examined in isolated studies (Marikyan et al., 2021; Pitardi & Marriott, 2020) yet. Based on their research models, the following final hypotheses are added to the hypotheses H1 to H9 listed above:

- H10: Existing privacy concerns about smart home devices have a negative impact on the attitude toward using them.
- H11: Existing privacy concerns about smart home devices have a negative impact on the trust in them.

The term *privacy concerns* is used in the hypotheses, taking into account Sweeny and Dooley's (2017) definition of a concern as a person's repeated thoughts focusing on negative events related to the informal autonomy or privacy it can prepare for or which it can foresee.

For clarity, the relationships between the hypotheses are shown graphically in Figure 2. A detailed explanation of the operationalization of the listed constructs follows in the next chapter.

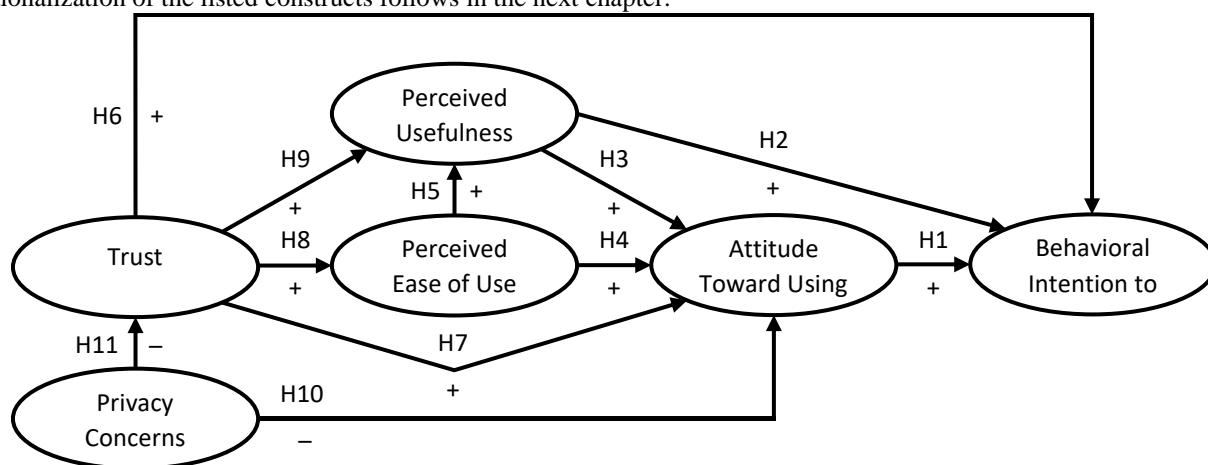


Figure 2: Research model.

METHODOLOGY

Methodological Approach

The empirical study focuses on the German smart home market. Since the full range of functions of smart home devices can usually only be achieved with an internet connection, the total number of internet users living in Germany at the time of the study was defined as the population. In 2021, this included around 66.6 million people aged 14 and over (GIM, 2021). The investigation units were selected in the form of a self-selected sample from the population. As a research method, a quantitative online survey in the form of a computerized self-administered questionnaire was then carried out with them. Due to the selected population, a coverage-related problem could be avoided.

The survey was carried out using smart home thermostats as an application example for examination. This approach was taken to ensure that respondents think of the same device when they hear the generic term 'smart home device' while answering the questions on the variables being studied. Smart home thermostats were chosen as an example device for a variety of reasons: First of all, the chosen definition of smart home devices in this paper applies exactly to them and their basic functional orientation is similar to that of many other devices that fall under that definition. Furthermore, smart home thermostats are highly relevant in the German smart home context. Their purpose relates to two of the three most frequently mentioned reasons for using smart home devices—comfort or quality of life and energy efficiency. Smart home thermostats are among the most used smart home devices (after smart lighting and alarm systems) and have the highest number of planned new purchases (Bitkom, 2020). They can be used in almost any living space and their usability or functionality is sufficiently versatile to ask about the attitude dimensions of the study participants related to them. Especially for examining the variable privacy concerns, smart home thermostats as an exemplary device offer decisive advantages: Many of their functions require a connection to the internet. As long as this exists, there are also privacy risks that can raise privacy concerns among users. Leading manufacturers are promoting online capabilities as the primary value proposition of their smart home thermostats, making an internet connection almost implicit (although not mandatory) when using these devices. Examples of such functions are remote control

(via app or voice assistant), geofencing (automation based on user presence in a certain area), weather forecast control, and the use of artificial intelligence to optimize heating.

The empirical data was analyzed by structural equation modeling (SEM). For this, we used the statistics standard software R (version 4.2.0) as well as the package lavaan (version 0.6-11).

Operationalization

The operationalization of the constructs is based on scales from various preceding studies that are already empirically shown to be reliable. All items are originally in English. Since we aimed at participants from Germany, the survey is in German such that the items had to be translated into German. Due to the different study orientations, the composition of the item blocks was mostly not suitable for the research interest of this paper. Therefore, items from different studies were combined and adapted to the context of smart home thermostats.

In total, 18 items regarding six constructs were used in the survey. Table 1 shows the English versions of these items. The characteristics of behavioral intentions and attitude dimensions of the survey participants were measured using five-point Likert scales (*do not agree at all, tend not to agree, neither, tend to agree, and fully agree*).

Table 1: Operationalization of the examined constructs

Construct	Code	Indicator	Item	Source						
Behavioral intention to use	BI	Planned... ...use	<i>I would...</i> ...like to use smart home thermostats.	Tereschenko (2020)						
		...frequency ...recommendation	...use smart home thermostats as much as possible. ...recommend smart home thermostats to other people.	Park et al. (2017)						
Attitude toward using	AU	Incentive	The thought of using smart home thermostats is appealing to me.	Pitardi & Marriott (2020)						
		Positive feelings	I have generally positive feelings toward using smart home thermostats.							
		Positive opinion	Overall, I think using smart home thermostats is a good idea.							
Perceived usefulness	PU	Perceived... ...service or information provision ...comfort ...lifestyle fit	<i>I think...</i> ...smart home thermostats would provide me with useful services and information. ...it would be comfortable for me to use smart home thermostats. ...smart home thermostats would be useful for my lifestyle.	Park et al. (2017)						
		Perceived ease of use	PE		Perceived... ...learnability of use ...daily usability ...improvement in use	<i>I think it would be easy for me to...</i> ...learn how to use smart home thermostats. ...use smart home thermostats in everyday life. ...become skillful at using smart home thermostats.	Pitardi & Marriott (2020)			
					(System-like) Trust	ST		Attributed... ...functionality ...reliability	<i>I think smart home thermostats...</i> ...have the right properties and features for my needs. ...are very safe and reliable.	Tereschenko (2020)
								...trustworthiness	...are trustworthy.	
Privacy concerns	PC	Concerns about... ...amount of data ...data privacy	<i>I have concerns about...</i> ...the amount of information... ...the confidentiality of the information...	Pitardi & Marriott (2020)						
		...manufacturer data usage	...the manufacturer's use of the information... ...that smart home thermostats collect about me and my interactions with them.		Dinev & Hart (2006)					

Before the questionnaire was finally rolled out, a number of pre-tests were carried out. In addition to a systematic analysis of the selected items according to Faulbaum et al. (2009), cognitive interviews were also conducted with 15 test participants using the methods of probing, confidence rating, and thinking-aloud. The feedback from those pretests made it clear that the test participants found the questionnaire to be very understandable, intuitive, and appealing. Furthermore, various suggestions for improvement were obtained, which were also implemented after weighing up possible advantages and disadvantages.

Sample

The online survey was conducted from the 14th until the 27th of March, 2022. After those two weeks of data collection, we gathered 427 data sets of which 353 (82.67%) were complete. From those 353, we excluded 27 data sets due to zero response variance (eight cases of straight liners) or a response time of less than half of the median, i.e., less than 1:50 min. (median

response time: 3:40 min.; 23 cases of speeders—partly overlapping with straight liners). Consequently, we could gather a sample of 324 valid data sets.

In the sample, around two-thirds (65.1%) have experience with smart home appliances (34.3% no experience; 0.6% not specified). 44.1% of the respondents (or 65.1% of the smart home users) have been using smart home appliances for at most three years, whereas only 13.9% have five years of experience or more. The comparison of the sample with the German population of web users in Table 2 shows that the sample is 10 years younger (32 vs. 42 years), slightly more female (54% vs. 50%), and substantially better educated (86% vs. 38% high education level) than the overall German population.

Table 2: Comparison sample and German population of web users

	Age	Sex		Education		
	Avg. (Years)	Female	Male	Low	Medium	High
Sample	32	54%	44%	1%	14%	86%
Germany	42	50%	50%	30%	32%	38%

Sources: GIM (2021) for Age, Sex; Initiative D21 (2022) for Education.

Reliability and Validity

Regarding the reliability of the empirical measurement, all latent constructs obtain a Cronbach’s alpha over the threshold of 0.7. Thus, the reliability can be confirmed based on a “good” to “excellent” consistency reaching from 0.781 to 0.935 (see Table 3).

Table 3: Reliability and validity indicators

	BI	AU	PU	PE	ST	PC
Cronbach’s alpha	0.914	0.917	0.858	0.933	0.781	0.935
Consistency (after Taber, 2018)	“strong”	“strong”	“good”	“excellent”	“good”	“excellent”
Avg. variance extracted (AVE)	0.786	0.796	0.675	0.826	0.598	0.833
Max. squared correlation	0.922	0.953	0.953	0.148	0.632	0.381
Max. HTMT ratio	0.910	0.938	0.938	0.380	0.859	0.533

The confirmatory factor analysis shows an average variance extracted (AVE) of 0.598 to 0.833, i.e., all factors are above the threshold of 0.5, which indicates convergent validity. Concerning discriminatory validity, the Fornell-Larcker test (1981) requires that the AVE is larger than the maximal squared correlation ($\max r_{ij}^2 \forall i \neq j$), which is not the case for BI, AU, and PU due to their very high correlations (0.939, 0.960, and 0.976) (see Table 5). PE and PC pass the Fornell-Larcker test completely, whereas ST does not meet the requirement technically, but is qualitatively acceptable. Another more advanced discriminatory validity assessment is the Heterotrait-monotrait (HTMT) ratio of correlations (Henseler et al., 2015) which should be at least below 0.9 or, more conservatively, below 0.85. These calculations confirm the discriminatory insufficiencies of BI, AU, and PU that we will account for in the discussion. For ST, the HTMT ratio of 0.859 is below 0.9 and almost below 0.85, which shows an acceptable discriminatory validity.

RESULTS

In this section, we present the results of the descriptive and inductive statistics from the 324 complete data sets in the survey.

Table 4: Descriptive statistics (summated multi-item scale scaled to 1 – 5)

	BI	AU	PU	PE	ST	PC
Min	1.000	1.000	1.000	1.000	1.000	1.000
1st Quartile	3.333	3.667	3.333	4.000	3.333	2.000
Median	4.000	4.000	4.000	4.667	3.667	3.000
3rd Quartile	4.333	4.667	4.333	5.000	4.000	4.000
Max	5.000	5.000	5.000	5.000	5.000	5.000
Mean	3.746	3.900	3.825	4.400	3.645	3.104
SD	1.016	0.968	0.943	0.765	0.774	1.175
CoV	27.1%	24.8%	24.7%	17.4%	21.2%	37.9%

Table 4 shows the results of the descriptive statistics of the six latent factors. For illustration and interpretation purposes, we draw on the sum of the respective items here (scaled to 1 – 5). In the remainder of the paper, we use the factor scores resulting from the SEM, though. As the data shows, all constructs comprise the full spectrum of possible answers with a minimum of 1

(answering all items with complete disagreement) and a maximum of 5 (answering all three items with complete agreement). PE has the highest average score (4.400) with the smallest coefficient of variation (CoV; 17.4%), which is an indicator that smart home technology has achieved apprehended usability. PU (3.825), AU (3.900), and BI (3.746) have less but also relatively high approval scores. With ST (3.645) and especially PC (3.104), the respondents are expectedly more skeptical, albeit those two constructs also receive a fair amount of agreement.

In terms of bivariate correlation (see table 5; now based on factor scores from the SEM), the data shows a very high pairwise correlation coefficient between BI, AU, and PU (0.939 – 0.976) being almost perfectly positively correlated. PE shows a moderate positive effect on each variable (0.306 – 0.385) except for PC, which is substantially negatively correlated (-0.617). Generally, PC shows negative effects on the other factors (-0.617 – -0.242). Except for PC, ST is statistically positively associated with the other variables with a moderate effect on PE (0.331) and even a large effect on PU, AU, and BI (0.708 – 0.795).

Table 5: Correlation matrix (based on factor scores)

	BI	AU	PU	PE	ST	PC
BI	1	0.939	0.960	0.306	0.708	-0.302
AU		1	0.976	0.385	0.795	-0.348
PU			1	0.357	0.739	-0.297
PE				1	0.331	-0.242
ST					1	-0.617
PC						1

To check for normality in the SEM data, we calculated Mardia’s multivariate skew and kurtosis statistics: the data possess a significant positive skewness (right-skewed) as well as an excess kurtosis (leptokurtic)—both with $p < 0.0001$ —indicating non-normality (which is also hinted graphically by the Q-Q plot; not depicted). Therefore, we computed the SEM with the estimation method “Maximum Likelihood Mean Adjusted” (MLM) applying a maximum likelihood approach and a scaling of the chi-square statistics according to Satorra-Bentler (2001) to adjust for non-normality in the fitness measures. The fitness measures (with said scaling) are shown in Table 6 along with suggested cutoff values (after Schermelleh-Engel et al., 2003) specifying the acceptability of the SEM. All fitness measures reach the suggested criteria except for the NNFI (Non-normed Fit Index), which shows a slight underfitting ($0.943 < 0.95$) whereas the NFI (Normed Fitness index) is adequate ($0.917 \geq 0.9$). However, the criterion of ≥ 0.9 was originally also applied for the NNFI (Hu & Bentler, 1999) which would have been satisfied in this model. In summarizing, the model manifests adequate fit properties.

Table 6: Fit of the SEM (Satorra-Bentler corrected)

Measure	χ^2 / df	RMSEA	p-value (RMSEA ≤ 0.05)	SRMR	CFI	NFI	NNFI
Value	2.129	0.059	0.028	0.082	0.954	0.917	0.943
Cutoff	≤ 3	≤ 0.08	≤ 0.05	≤ 0.1	≥ 0.95	≥ 0.9	≥ 0.95

Note: *df* = degrees of freedom, *RMSEA* = Root Mean Square Error of Approximation, *SRMR* = Standardized Root Mean Square Residual, *CFI* = Comparative Fit Index, *NFI* = Normed Fit Index, *NNFI* = Non-normed Fit Index. Cutoff values taken from Schermelleh-Engel et al. (2003).

Table 7 shows the results of the estimation of the SEM path coefficients as well as their significance. Regarding the paths towards BI, PU has a particularly high effect ($\beta = 0.803$) that is also very highly significant ($p < 0.001$). On the other hand, ST does not seem to influence BI ($p = 0.914$). For AU, the data is inconclusive as the 95% confidence interval (CI) of β reaches from -0.021 to 0.667 ($p = 0.066$). The overall R^2 of BI is 85.2% explained variance, which is a substantial effect size after Chin (1998). The path model of AU also has a substantial effect size with an R^2 of 90.4%. The paths of $PU \rightarrow AU$ ($\beta = 1.037$; $p < 0.001$) and $ST \rightarrow AU$ ($\beta = 0.377$; $p < 0.01$) show a very strong evidence in particular. In contrast, there is effectively no evidence supporting the influence of PE and PC on AU ($p = 0.192$ and $p = 0.652$, respectively). For PU (with a moderate effect based on a R^2 of 46.7%), the influence factors PE ($\beta = 0.142$; $p < 0.01$) and especially ST ($\beta = 0.887$; $p < 0.001$) indicate a strong relationship with PU. The path model of PE with only one explanatory variable has a limited explained variance ($R^2 = 9.1\%$, very weak effect size). However, the only path of this sub-model, $ST \rightarrow PE$, is highly significant ($\beta = 0.434$; $p < 0.001$). Finally, the $PC \rightarrow ST$ shows very strong evidence for a negative relationship ($\beta = -0.276$; $p < 0.001$) that can explain 32.6% of the variance of ST and is a weak to moderate effect.

After analyzing the direct effects of the respective path sub-models, we computed the indirect effect as well as the total effect (combining indirect and direct effect) on BI in the overall model for every other factor—as shown in Table 8.

Table 7: Results of the SEM

Paths towards BI (R ² : 0.852)	Coefficient	95% CI	Std. Error	p-value
AU → BI	0.323	-0.021 – 0.667	0.176	0.066
PU → BI	0.803	0.381 – 1.225	0.215	0.000
ST → BI	-0.011	-0.213 – 0.191	0.103	0.914
Paths towards AU (R ² : 0.904)	Coefficient	95% CI	Std. Error	p-value
PU → AU	1.037	0.874 – 1.2	0.083	0.000
PE → AU	0.055	-0.028 – 0.139	0.042	0.192
PC → AU	0.015	-0.051 – 0.082	0.034	0.652
ST → AU	0.377	0.164 – 0.59	0.109	0.001
Paths towards PU (R ² : 0.467)	Coefficient	95% CI	Std. Error	p-value
PE → PU	0.142	0.041 – 0.243	0.052	0.006
ST → PU	0.887	0.673 – 1.1	0.109	0.000
Paths towards PE (R ² : 0.091)	Coefficient	95% CI	Std. Error	p-value
ST → PE	0.434	0.253 – 0.614	0.092	0.000
Paths towards ST (R ² : 0.326)	Coefficient	95% CI	Std. Error	p-value
PC → ST	-0.276	-0.342 – -0.211	0.033	0.000

Since AU has no indirect connection to AU, it only comprises its direct effect (see above, $\beta = 0.323$; $p = 0.066$) which is logically the same as its total effect. Whereas PU's indirect effect is inconclusive yet (95% CI: -0.013 – 0.683; $p = 0.059$), its total effect adding the direct influence is highly evident ($\beta = 1.138$; $p < 0.001$). PE as well as PC only consists of indirect effects that show a small positive and medium negative, but statistically significant, impact on BI ($\beta = 0.179$; $p < 0.01$ and $\beta = -0.326$; $p < 0.001$). Eventually, while ST has effectively no evidence of directly influencing BI ($\beta = -0.011$; $p = 0.914$), its indirect effect strongly suggests a significant mediated relationship ($\beta = 1.208$; $p < 0.001$) leading to the strongest total effect in the SEM ($\beta = 1.197$; $p < 0.001$).

Table 8: Indirect and Total Effects on BI

	Indirect Effect				Total Effect			
	Coefficient	95% CI	Std. Error	p-value	Coefficient	95% CI	Std. Error	p-value
AU	--	--	--	--	0.323	-0.021 – 0.667	0.176	0.066
PU	0.335	-0.013 – 0.683	0.178	0.059	1.138	0.961 – 1.315	0.090	0.000
PE	0.179	0.066 – 0.293	0.058	0.002	0.179	0.066 – 0.293	0.058	0.002
ST	1.208	0.916 – 1.501	0.149	0.000	1.197	0.937 – 1.458	0.133	0.000
PC	-0.326	-0.404 – -0.247	0.040	0.000	-0.326	-0.404 – -0.247	0.040	0.000

DISCUSSION AND CONCLUSION

Discussion of the Hypotheses

The outcomes of the eleven hypotheses based on the empirical study are shown in Table 9.

Table 9: Hypotheses Evaluation

H.	Path	Sig.	Conclusion	H.	Path	Sig.	Conclusion
H1	AU → BI	°	<i>inconclusive</i>	H7	ST → AU	***	<i>accepted</i>
H2	PU → BI	***	<i>accepted</i>	H8	ST → PE	***	<i>accepted</i>
H3	PU → AU	***	<i>accepted</i>	H9	ST → PU	***	<i>accepted</i>
H4	PE → AU		<i>rejected</i>	H10	PC → AU		<i>rejected</i>
H5	PE → PU	**	<i>accepted</i>	H11	PC → ST	***	<i>accepted</i>
H6	ST → BI		<i>rejected</i>	<i>significance codes</i> ° < 0.1, * < 0.05, ** < 0.01, *** < 0.001			

Firstly, the hypotheses H1–H5 have addressed general technology acceptance variables based on the TAM (Davis, 1989). The influence of AU could not be shown on a 0.05 significance level. Since the p-value is a continuous measurement of evidence, the p-value of 0.066 is suggestive, but not conclusive (Murtaugh, 2014). As meta-studies on technology acceptance such as Blut et al. (2016) or Yousafzai et al. (2007) have shown, the connection between AU and BI is usually highly significant—the correlation of 0.939 in this study also indicates this close statistical connection. Nevertheless, BI, AU, and PU have failed the Fornell-Larcker test and the HTMT ratio threshold showing a lack of discriminatory validity, i.e., the measurements of the constructs are not sufficiently distinct to differentiate between those three variables. This fact may very likely interfere with the conclusion, since H2 (PU → BI) and H3 (PU → AU) are very highly significant and, thus, accepted. Regarding the perceived ease of use, the data indicates a significant positive relation between PE and PU such that H5 is accepted. H4 (PE → AU) is rejected due to lacking significance, though. In this regard, the meta-study of Yousafzai et al. (2007) shows that 18% of the 52 analyzed TAM studies did not find a significant positive correlation between PE and AU. In this study, the items of PE have a very easy item difficulty (the average score of PE is 4.4 out of 5 with item difficulties between 87.59% and 88.64%). Item difficulties above 80% lead to the so-called ceiling effect that does not allow for discrimination between subjects with high approval (Austin & Brunner, 2003) which might have interfered with our analysis despite the excellent internal consistency of the factor. Nevertheless, PE shows a highly significant total effect on BI due to the moderation via PU.

Secondly, the hypotheses H6–H9 have addressed the impact of ST on the factors BI (H6), AU (H7), PE (H8), and PU (H9). H6 could not be confirmed despite the very high correlation of 0.708 between ST and BI. Since ST also influences AU and PU, the lack of discrimination once again might interfere with this result. However, the data shows a very high significance regarding AU, PE, and PU such that H7, H8, and H9 can be confirmed. Previous work studying the effects of ST observed similar outcomes. For instance, Wu et al. (2011) confirmed in their meta-study the significant influence of ST on AU, PE, and PU. Moreover, they also found a significant weighted mean effect size of 0.527 in the ST–BI relationship with a failsafe N of 196,63. This further supports the assumption above on the interference of the lack of discrimination with the results regarding H6.

Thirdly, the two final hypotheses H10–H11 have addressed the role of PC. Different than expected, PC only showed an traceable influence on ST and none on AU. H10 has therefore to be rejected while H11 can be accepted. This outcome is contrary to the study by Pitardi and Marriott (2021) regarding voice assistants. They found an influence of PC on AU, but none on trust. However, their operationalization of trust primarily related to the communication of the voice assistant and largely corresponded to the (quasi-)interpersonal trust as described by Mayer et al. (1995) and McKnight et al. (2002). Against this background, the result that concerns about more technical data privacy do not affect (quasi) interpersonal trust in a technology seems plausible. In contrast, the investigation within the scope of this paper did not have the (quasi) interpersonal trust, but the system-related trust according to McKnight et al. (2011) to the subject. The proven mediation of the influence of PC via ST on AU could explain why Pitardi and Marriott (2021) perceived this influence of PC on AU as direct without considering ST. Regarding the negative effect of PC on ST, the results of this paper show very supportive evidence in accordance with previous studies such as Chang et al. (2017), Zhou (2011), and Liu et al. (2005). Concerning the moderated effect on BI, PC shows a substantial negative indirect effect of -0.326 on BI, mainly moderated by ST.

Practical Implications

For practitioners from the smart home domain, we can recommend three key aspects based on our findings:

Firstly, smart home devices should be designed for maximum perceived usefulness and trust. Regarding the former, product designers should think about optimizing service or information provision, comfort, and lifestyle fit towards the user. Regarding the latter, the indicators of functionality, reliability, and trustworthiness are relevant in this context.

Secondly, as the descriptive statistics and the easy item difficulties have shown, the maturity in terms of perceived ease of use appears to be relatively high. Furthermore, the total effect on the behavioral intention to use has been the lowest of all analyzed variables. Therefore, perceived ease of use of smart home devices should not be given too much attention during product development.

Thirdly, the smart home manufacturers should highlight trust and privacy concerns characteristics in their advertisements and customer communication. As we have shown, these two factors have a substantial positive or negative, respectively, impact on the behavioral intention to use. Simultaneously, both issues are easy to address within the customer address—in contrast to perceived usefulness which more heavily relies on physical features than on comprehensive dispositions.

Limitations

The generalizability of our findings is subject to certain limitations in our research design, the available literature, and our empirical measurement:

Addressing our research design, we have chosen smart home thermostats as an exemplary technology. This may not be representative of smart home technologies in general. Furthermore, to assure an informed response, we have provided basic information about smart thermostat features by an introductory text at the beginning of the survey. Although potential users

might also inform themselves before their purchase, the given information might have biased the responses in any manner. To keep this risk as little as possible, we tried to follow and imitate real product information texts.

Concerning the available literature, the literature search appeared to be challenging because smart home devices are relatively young technologies that have not been researched extensively from a technology acceptance perspective yet.

Regarding the empirical measurement, we must limit our findings to the German context since the survey was not only written in German but also exclusively conducted among German residents. As we have argued, the average respondent in our sample is a little younger but by far more formally educated than the average German online user. Finally, the statistical analysis of the results revealed two weaknesses of the data: Firstly, the constructs of BI, AU, and PU fail to establish a sufficient discriminatory validity leaving some uncertainty about the outcomes of their direct interactions—even though the goal of this study is not the replication of these core TAM construct. Secondly and lastly, the measurement of PE shows very easy item difficulties leading to a ceiling effect that hinders the discrimination between subjects with high PE.

Conclusion and Future Work

In the field of acceptance research, various models for the general prediction of technology acceptance have been established. However, trust and privacy concerns have been hardly taken into account yet—especially in the context of smart home devices. Nevertheless, our results demonstrate a very strong positive effect of trust on smart home technology acceptance as well as a moderate negative impact of privacy concerns showing the relevance of these factors.

Based on the findings, this paper provides three main theoretical contributions: firstly, the paper conceptionally adds the special relationships of trust and privacy concerns with the determinants of use to the technology acceptance theory in the context of smart home devices. Secondly, the study provides empirical evidence for those relationships and can show that they can play an important role in technology acceptance. Thirdly, this work studies smart home adoption based on the example of smart thermostats and, by doing so, generates original insights and explanations of the phenomenon.

Future work will be to further validate the theoretical contributions made in this paper. To achieve this, investigations have to be carried out using a more representative sample and with various smart home devices as a basis for the survey. For an even broader understanding, additional investigations need to be conducted in different countries and different contexts of use. Furthermore, the specific drivers of users' trust in smart home devices need to be identified. This would give manufacturers and software operators more substantiated insights on how to develop and advertise their smart home devices accordingly in order to achieve higher user acceptance.

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**APPENDIX:
Questionnaire**

10% ausgefüllt

Zum Einstieg starten wir mit einer allgemeinen Frage zu Ihrem **bisherigen Kontakt mit Smart-Home-Geräten**.

Smart-Home-Geräte sind im weiteren Sinne intelligente Geräte für den **Heimbereich**, die sich mit anderen Geräten in einem **Funknetzwerk** verbinden lassen und dadurch **ferngesteuert, geplant** oder als **eigenständige Reaktion auf Umweltreize** Aufgaben erfüllen können.

In welchen Anwendungsbereichen nutzen Sie bereits Smart-Home-Geräte?

Energiemanagement (z. B. Beleuchtung, Heizung)

Gebäude- & Wohnsicherheit (z. B. Alarmanlage, Rauchmelder)

Entertainment & Kommunikation (z. B. TV- und Audiogeräte)

Hausautomation & Komfort (z. B. Rollläden, Staubsauger)

Gesundheit & Alltagsassistentz (z. B. Sturzmonitor, Havanotruf)

Ich nutze keine Smart-Home-Geräte.

Figure 3: Question module on contact to smart home devices.

20% ausgefüllt

Nun bitte ich Sie, sich den folgenden Text aufmerksam durchzulesen.

Er enthält grundsätzliche **Informationen über smarte Heizungsthermostate**.

Die Fragen auf den nachfolgenden Seiten werden sich auf diese Technologie beziehen.

Wenn Sie fertig sind, klicken Sie bitte auf „Weiter“.

Smart-Home-Thermostate

Nutzen

- Hohe Genauigkeit und viele Zusatzfunktionen
- Senkung des Energieverbrauchs und Erhöhung des Wohnkomforts durch Automatisierung der Heizvorgänge

Generelle Funktionen

- Heizverhalten basiert weitgehend auf vorab eingestellten raumindividuellen Zeitplänen und erfasster Raumtemperatur
- Verschiedene Sensoren ermöglichen situative Anpassung des Heizverhaltens außerhalb der Zeitpläne bei anhaltender Raumnutzung (Helligkeit, Bewegung, Geräusch etc.) oder geöffnetem Fenster

Internet-Funktionen

- Fernsteuerung per Smartphone, Sprachassistent etc. (auch manuelle Bedienung möglich)
- Automatisches An- und Abschalten je nach Anwesenheit der Bewohner*innen
- Einbezug der Wettervorhersage in das Heizverhalten
- Online-Datenspeicherung für Statistiken über Heizverhalten, Energieverbrauch etc.
- Verbindung zum Hersteller zwecks Updates, Produktentwicklung, individuellem Marketing etc.
- Künstliche Intelligenz zur Heizoptimierung auf Basis erfasster Daten über die Raumnutzungsgewohnheiten der Bewohner*innen




Figure 4: Information text on smart home devices.

30% ausgefüllt

Im folgenden Fragenblock geht es um Ausprägungen Ihrer **Nutzungsabsicht** gegenüber Smart-Home-Thermostaten.
Bitte kreuzen Sie jeweils die für Sie passende Antwort an und lassen Sie dabei eventuelle Kosten solcher Geräte außer Acht.
Wenn Sie bereits Smart-Home-Thermostate nutzen, antworten Sie bitte entsprechend.

Wie sehr stimmen Sie den nachfolgenden Aussagen zu?

	stimme gar nicht zu	stimme eher nicht zu	weder noch	stimme eher zu	stimme voll zu
	1	2	3	4	5
Ich würde Smart-Home-Thermostate...					
...gerne nutzen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...so viel wie möglich nutzen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...anderen Personen empfehlen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 5: Question module on behavioral intention to use.

60% ausgefüllt

Nun geht es um Ausprägungen Ihrer **grundsätzlichen Einstellung** gegenüber Smart-Home-Thermostaten.
Bitte kreuzen Sie jeweils die für Sie passende Antwort an und lassen Sie dabei eventuelle Kosten solcher Geräte außer Acht.
Wenn Sie bereits Smart-Home-Thermostate nutzen, antworten Sie bitte entsprechend.

Wie sehr stimmen Sie den nachfolgenden Aussagen zu?

	stimme gar nicht zu	stimme eher nicht zu	weder noch	stimme eher zu	stimme voll zu
	1	2	3	4	5
Der Gedanke an die Nutzung von Smart-Home-Thermostaten spricht mich an.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ich habe grundsätzlich positive Gefühle gegenüber der Nutzung von Smart-Home-Thermostaten.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ich denke, die Nutzung von Smart-Home-Thermostaten ist insgesamt eine gute Idee.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 6: Question module on attitude toward using.

50% ausgefüllt

Nun geht es um Ausprägungen Ihres **Vertrauens** gegenüber Smart-Home-Thermostaten.
Bitte kreuzen Sie jeweils die für Sie passende Antwort an.

Wie sehr stimmen Sie den nachfolgenden Aussagen zu?

	stimme gar nicht zu	stimme eher nicht zu	weder noch	stimme eher zu	stimme voll zu
	1	2	3	4	5
Ich denke, Smart-Home-Thermostate...					
...besitzen die passenden Eigenschaften und Funktionen für meine Anforderungen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...sind sehr sicher bzw. verlässlich.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...sind vertrauenswürdig.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 7: Question module on trust.

79% ausgefüllt

Nun geht es um Ausprägungen Ihrer **Überzeugung zur Nützlichkeit** von Smart-Home-Thermostaten.
Bitte kreuzen Sie jeweils die für Sie passende Antwort an.
Wenn Sie bereits Smart-Home-Thermostate nutzen, antworten Sie bitte entsprechend.

Wie sehr stimmen Sie den nachfolgenden Aussagen zu?

	stimme gar nicht zu	stimme eher nicht zu	weder noch	stimme eher zu	stimme voll zu
	1	2	3	4	5
Ich denke, ...					
... Smart-Home-Thermostate würden mir nützliche Dienste und Informationen bereitstellen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... es wäre für mich komfortabel, Smart-Home-Thermostate zu nutzen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... Smart-Home-Thermostate wären nützlich für meinen Lebensstil.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 8: Question module on perceived usefulness.

48% ausgefüllt

Nun geht es um Ausprägungen Ihrer **Überzeugung zur Bedienfreundlichkeit** von Smart-Home-Thermostaten.
Bitte kreuzen Sie jeweils die für Sie passende Antwort an.
Wenn Sie bereits Smart-Home-Thermostate nutzen, antworten Sie bitte entsprechend.

Wie sehr stimmen Sie den nachfolgenden Aussagen zu?

	stimme gar nicht zu	stimme eher nicht zu	weder noch	stimme eher zu	stimme voll zu
	1	2	3	4	5
Ich denke, es würde mir leicht fallen, ...					
... die Bedienung von Smart-Home-Thermostaten zu erlernen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... Smart-Home-Thermostate im Alltag zu bedienen.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... geübt in der Bedienung von Smart-Home-Thermostaten zu werden.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 9: Question module on perceived ease of use.

80% ausgefüllt

Dies ist der **vorletzte** Fragenblock.
Dabei geht es um Ausprägungen Ihrer **Datenschutzbedenken** bei Smart-Home-Thermostaten.
Bitte kreuzen Sie jeweils die für Sie passende Antwort an.

Wie sehr stimmen Sie den nachfolgenden Aussagen zu?

	stimme gar nicht zu	stimme eher nicht zu	weder noch	stimme eher zu	stimme voll zu
	1	2	3	4	5
Ich habe Bedenken über...					
... die Menge an Informationen, die Smart-Home-Thermostate über mich und meine Interaktionen mit ihnen sammeln.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... die Vertraulichkeit der Informationen, die Smart-Home-Thermostate über mich und meine Interaktionen mit ihnen sammeln.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
... die herstellenseitige Nutzung der Informationen, die Smart-Home-Thermostate über mich und meine Interaktionen mit ihnen sammeln.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 10: Question module on privacy concerns

Soft systems modelling of design artefacts for blockchain-enabled precision healthcare as a service

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ABSTRACT

Precision Healthcare (PHC) is a disruptive innovation in digital health that can support mass customisation. However, despite the potential, recent studies show that PHC is ineffectual due to the lower patient adoption into the system. This paper presents a Blockchain-enabled PHC ecosystem that addresses ongoing issues and challenges regarding low opt-in rates. Soft Systems Methodology was adopted to create and validate UML design artefacts. Research findings report that there is a need for data-driven, secure, transparent, scalable, individualised and precise medicine for the sustainability of healthcare and suggests further research and industry application of explainable AI, data standards for biosensor devices, affordable Blockchain solutions for storage, privacy and security policy, interoperability, and user-centricity.

Keywords: Blockchain, Precision Healthcare, Trust, Sustainability.

INTRODUCTION

PHC can be defined as the integration of emerging technologies that can provide tailored medical treatment for individuals in optimised time and cost, along with navigation, interoperability, and scalability. Its potential is evident with the gradual decrease in genome sequencing prices (Zimmerman, 2013). Furthermore, PHC is potential to improve medication errors (Harvard Business Review, 2018), address ongoing health workforce constraints (Rogers, 2019), and, most importantly, reduce conventional healthcare expenses (Bíró et al., 2018; Hull, 2018). Due to data centrality, PHC's efficacy depends on the volume of health data and applied analytics (Sharma et al., 2019). In contemporary healthcare, PHC initiatives only address chronic diseases (e.g., cancer, tumour, diabetes) (Barker, 2017; Zahid, 2021). Therefore, despite its potential, PHC is currently found to be inefficient in performance due to low adoption by stakeholders.

Empirical evidence shows that people refrain from adopting PHC due to distrust (Sharma et al., 2019). Furthermore, the gradual increase of breach incidents (e.g. cyberattacks) in digital health systems (GDHP, 2019b), the probability of unauthorised health data access and viewing, the possibility of unsatisfactory physician-patient relationships, fear of embarrassment, stigma, and discrimination, and the possibility of disclosure of ethnic information (e.g. race, nationality) are playing the drastic role in compounding this distrust among people. Blockchain, an emerging technology for trust-less platforms, incorporates state-of-the-art characteristics such as decentralisation, encryption, tamper-resistance, traceability, immutability, and transparency; potential to address the issue of an acceptable Trusted Third Party (TTP). Therefore, this paper introduces a Blockchain-enabled PHC ecosystem that addresses the issue of trust in healthcare stakeholders and the resulting low adoption challenges. The research focuses on the design and empirical validation of the ecosystem artefact and sub-artefacts. The designed artefact and sub-artefacts are based on system design principles and rules discussed comprehensively in recent research studies and regulatory guidelines. As empirical evidence shows that the existing digital health infrastructure is incapable of satisfying the current and future health data needs (Svensson, 2019; Zahid et al., 2021), the designed ecosystem artefact and sub-artefacts also incorporate emerging information technologies that have the potential to ensure sustainable health data support, clarity, and trust among the stakeholders and facilitate uptake and adoption.

BACKGROUND REVIEW

The designing of the PHC ecosystem progressed with a comprehensive review of underlying technologies such as IoT, VR, AI and big data. The review outcomes (Zahid et al., 2021; Zahid, 2021) acknowledge these emerging information technologies' potential and suggest inclusion in the ecosystem design. More specifically, an extensive review of scholarly and practice-

oriented literature was conducted to understand the potential design principles and rules to ensure empathic design and trust in the ecosystem. A total of nine design principles and thirty design rules were identified. An iterative enhancement approach has been considered to refine and establish a comprehensive and parsimonious set of design principles which address the "what" question of designing the PHC ecosystem. These principles have spawned the associated design rules that address the "how" question of design artefacts of the ecosystem. These design principles and rules were further presented during the demonstration of the ecosystem to different healthcare industry clients and actors for refinement and validation. Figure 1 depicts the system design principles and rules that are applied for the design of the artefacts of the PHC ecosystem.

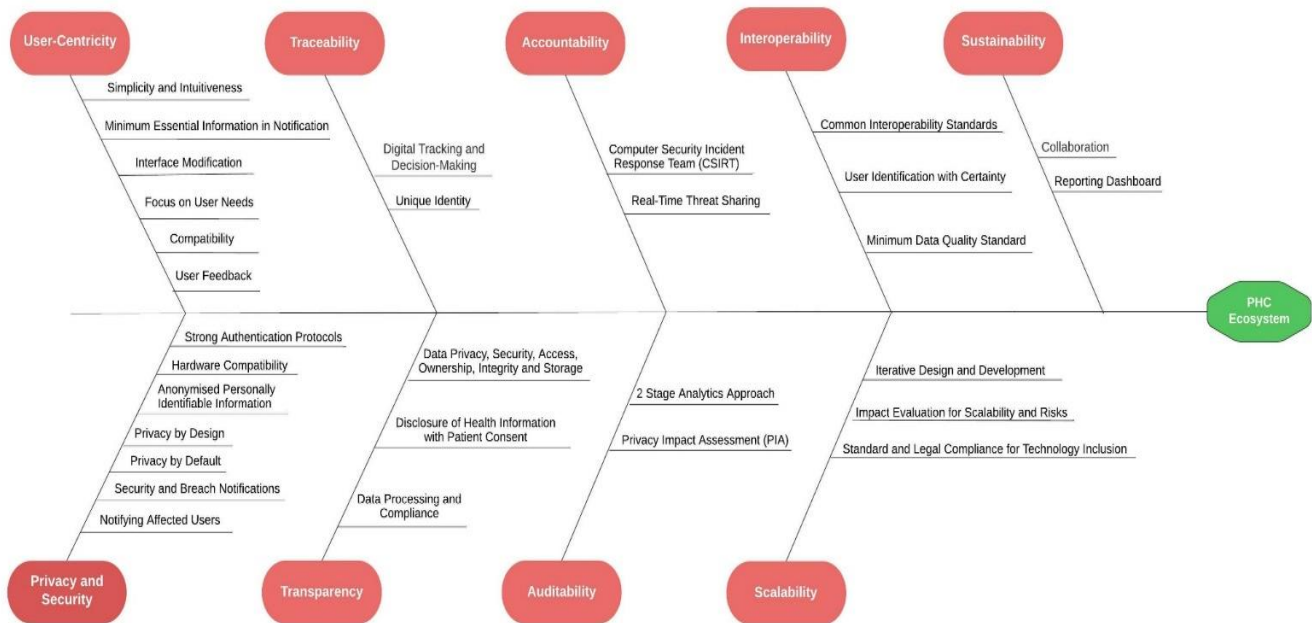


Figure1: Fishbone Diagram of System Design Principles and Rules for PHC Ecosystem.

User-Centricity

For a data-driven healthcare service like PHC, user-centricity is significant for success. Therefore, health policymakers must establish a user-centric system design guideline to ensure active user engagement and success. PHC service should be intuitive and straightforward to ensure user-centricity (Labrique et al., 2018; Nath & Sharp, 2015). It should include various social aspects (traditions, values, translation, environment) while designing services and interventions (Marwaha & Kvedar, 2021). Moreover, it should complement the practical, emotional, and clinical needs of the patient and other healthcare actors (UK Department of Health & Social Care, 2019; Cresswell et al., 2013; Imison et al., 2016; Principles for Digital Development Working Group, 2016d; Stickdorn & Schneider, 2012). Communications between patients and different healthcare actors through PHC service should be succinct, maintaining minimal essential information (Jackson et al., 2018; Phillips et al., 2015). Furthermore, besides computers, PHC service should be compatible with smart gadgets such as notebooks, smartphones, and tablets. It will potentially enrich health equity in remote settings. Lastly, PHC service should incorporate a functional user feedback mechanism to improve further the user-centricity and overall PHC service (Principles for Digital Development Working Group, 2016d).

Privacy and Security

Due to the recent growth of cyberattacks (GDHP, 2019b) and the possibility of unauthorised access to digital health services (Brothers & Rothstein, 2015), data privacy and security have been significant issues in every healthcare setting worldwide. Therefore, data privacy and security policy for PHC service should explicitly include regulations for data ownership, sovereignty, access and control over data usage and storage. It should be developed in straightforward language (Principles for Digital Development Working Group, 2016a). Personally identifiable information (PII) in the health data should be anonymised for any usage by the PHC service (Ipsos MORI, 2014; Health Data Exploration Project, 2014; Vithiatharan, 2014). In exceptional circumstances, de-anonymisation of PII must be strictly limited. In principle, it should be used for limited purposes, assuring users' data protection, minimisation, and transparency (GDPR, 2018). PHC service must include data security by design and default (GDPR, 2018). PHC service should also incorporate contemporary security techniques such as multi-factor authentication (Borde, 2007; Mikkelsen et al., 2020) besides conventional data privacy and security mechanisms. Furthermore, the PHC service should incorporate effective notification mechanisms to broadcast cyber-incident and breach notifications, security updates, and system updates (Fernandez-Aleman et al., 2015; Mikkelsen et al., 2020). Incorporating these into the data privacy and security policy will assure transparent service operations (GDPR, 2018; Mikkelsen et al., 2020), grow trust among PHC users, and encourage them to active participation and engagement.

Traceability

In today's data-driven environment, PHC service needs to be digital tracking enabled (Agarwal et al., 2018; WHO, 2018; Frøen et al., 2016). It is potential to: a) reduce delays in care delivery and treatment; b) provide assistance to the health practitioners in decision-making at the point of care; c) assist in the personalised healthcare cycle; d) schedule follow-up appointments and other related services (e.g. pathological tests, diagnosis); e) support in organising checklists for care management; and f) decrease cost and time of healthcare delivery at rural settings (WHO, 2019). Digital tracking is significant in a data-driven society to attract users and engage them in digital health services for care management and decision-making (TEFCA, 2018). WHO (WHO, 2019) recommends digital tracking in sharing health status and other related services (e.g. payment, appointment scheduling). Digital tracking should maintain strict data confidentiality. PHC service should incorporate appropriate technological solutions (e.g. Artificial Intelligence, Blockchain) to confirm the users' data privacy and confidentiality. Digital health services should be based on a unique identity management system (Imison et al., 2016; WHO, 2019; Yao et al., 2010). The unique identification management system can assist in the patient search, improve redundant entries in the user registry, and enhance intervention efficiency, quality of treatment, and care delivery (WHO, 2019). Moreover, it is competent to support information exchange (Interoperability) among various healthcare providers (WHO, 2019).

Transparency

Transparency means the predicted outcome from the input in a system cycle (Rouse, 2014b). It is one of the key demands of users in digital health services (Cordina & Greenberg, 2019), such as PHC. Transparency in PHC service can be designed by founding a data flow map. A data flow map can help categorise instances like data processing information (including trace and track of records) and exchanged data types (UK Department of Health & Social Care, 2019). However, a data flow map may cause data misuse (e.g. niche advertising) (Bigelow, 2018; Crawford et al., 2015). PHC service may include appropriate technology (e.g. Artificial Intelligence, Machine Learning, Deep Learning) to set up an informed consent management strategy within their system and service for creating and assuring the best transparency practice for all its users.

Accountability and Auditability

Gradual demand for transparency in digital health services (Cordina & Greenberg, 2019) has made accountability a significant issue in healthcare. Accountability helps to improve a system's auditability. Auditability denotes the ability to evaluate the existing system infrastructure, operations and regulation policies (Rouse, 2014a). Accountability and auditability enhance the traceability and transparency aspects of a digital health service. Therefore, to ensure traceability and information transparency, PHC service should maintain internationally recognised standards for data privacy, security and performance assessment. It may include collaboration initiatives such as a) Computer Incident Response Centre (Ruefle et al., 2013; GDHP, 2019b), b) Real-time threat sharing among various healthcare entities using traffic light protocol (GDHP, 2019b), c) Common Vulnerability Scoring System (CVSS) for all healthcare devices connected with the PHC service (GDPR, 2018; Mell et al., 2007), and d) Privacy Impact Assessment (PIA) (European Commission, 2016; GDPR, 2018). These initiatives assure accountability and auditability of the service as per the regulatory policy and add value to care delivery.

Interoperability

By definition, interoperability means the ability of strategic data access, interchange, integration, and application within health information systems and devices (HIMSS, 2020). Interoperability assures the "standard meaning" of data for all the connected healthcare entities. It enables seamless health data interchange within or beyond the facility and regional boundary. In the current digital health context, it is a pre-condition. Therefore, to achieve interoperability, digital health services such as PHC must confirm user identification with confidence in the system (GDHP, 2019a). It can be achieved by applying standardised identifiers, for instance, the national health index. PHC service must adopt an internationally recognised, common interoperability standard (European Commission, 2014; GDHP, 2019a; Ferranti et al., 2006; Liaw et al., 2014; McMorro, 2014). The PHC service providers may consider open-source platforms such as OpenMRS, CommCare, OpenSRP, and OpenDataKit. They may also consider proprietary interoperability standards such as FHIR. These interoperability standards are flexible to integrate and offer user-friendly features and support. Interoperability has the potential to improve the quality of coordinated care, access equity, and service delivery of PHC (GDHP, 2019a).

Scalability

Scalability is the expansion-ability of the system in proportion to the system's gradual need (Bondi, 2000). It is always demand driven. As the current technology infrastructure of digital health services is becoming ineffectual in supporting the current and future health data needs (Svensson, 2019; Zahid et al., 2021), PHC service must action for the needed system scalability. In compliance with the regulatory guideline, PHC service should be able to incorporate emerging information technologies and Fitness devices into the ecosystem. Moreover, they should strictly monitor minimum data quality standards and maintenance (Principles for Digital Development Working Group, 2016b; GDHP, 2019a). Governing and regulatory entities such as WHO (World Health Organization), IMF (International Monetary Fund), USAID (United States Agency for International Development), and United Nations have already introduced data quality assessment frameworks, strategies, and fundamental principles, which can be applied as reference for such assessments. The PHC service should also include a practical impact evaluation matrix (acknowledging factors such as expertise, priorities, time, and cost) for service scalability and associated risk (Principles for Digital Development Working Group, 2016b; GDHP, 2019a). It may bring effective assessment outcomes for the service scale (Principles for Digital Development Working Group, 2016c). Lastly, PHC service should also consider a

collaborative iteration approach for the service design, development, and improvement to achieve the highest possible service scale.

FIELD RESEARCH METHOD

This research adopts Soft System Methodology (SSM), a wholly consistent variant of Design Science Research (DSR) (Baskerville et al., 2009; Peffers et al., 2007). SSM applies systems thinking to tackle messy, problematic situations (Checkland & Poulter, 2010). SSM includes action-oriented processes for investigating "problematic situations". The researcher acquires knowledge of the situation through exploration and determines the needed action to improve the situation. In SSM, the learning of a researcher commences with a set of organised processes where exploration of a situation is determined through a set of models representing purposeful action, each developed to describe a single worldview. These intellectual tools or devices structure discussion and inform the researcher about the situation and how to improve it (Checkland & Poulter, 2010). Figure 2 depicts the classic 7-step SSM model (Checkland & Scholes, 1999a), including information on this research.

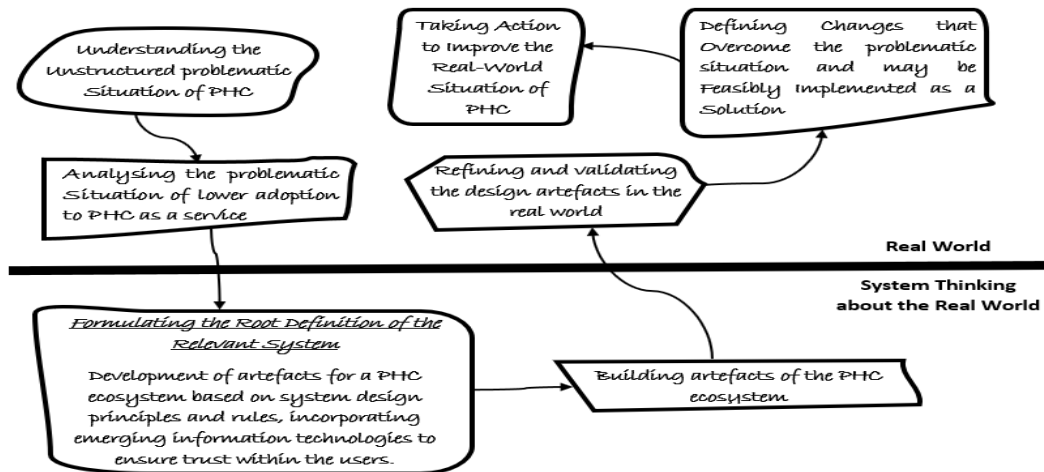


Figure 2: The Adopted Soft System Methodology Approach for the Study.

Step 1: Understanding the Unstructured Problematic Situation

The problem of this research is the inefficacy of PHC due to the "lower adoption" of users. Empirical evidence shows that people refrain from adopting PHC due to distrust (Sharma et al., 2019). A comprehensive review of PHC was conducted in this research to understand the unstructured problematic situation of PHC in detail. In the review, fear of cyberattack, unauthorised EHR view and access, disclosure of race, ethnicity, or nationality, suffering from stigma, embarrassment, and discrimination, and the unsatisfactory physician-patient relationship is identified as the plausible reasons for lower adoption of PHC service.

Step 2: Analysing the Problematic Situation of Lower Adoption to PHC as a Service

This step involves communicating and validating the problematic situation identified by the researcher. The step is purposed to confirm whether the widespread organisational actors acknowledge the identified problematic situation or not. To acquire this, a researcher can apply different types of tools. Checkland & Scholes (1999) recommends drawing a "rich picture", a detailed, unstructured illustration of the explored problematic situation. Figure 3 depicts the problematic situation of this study as a "rich picture".

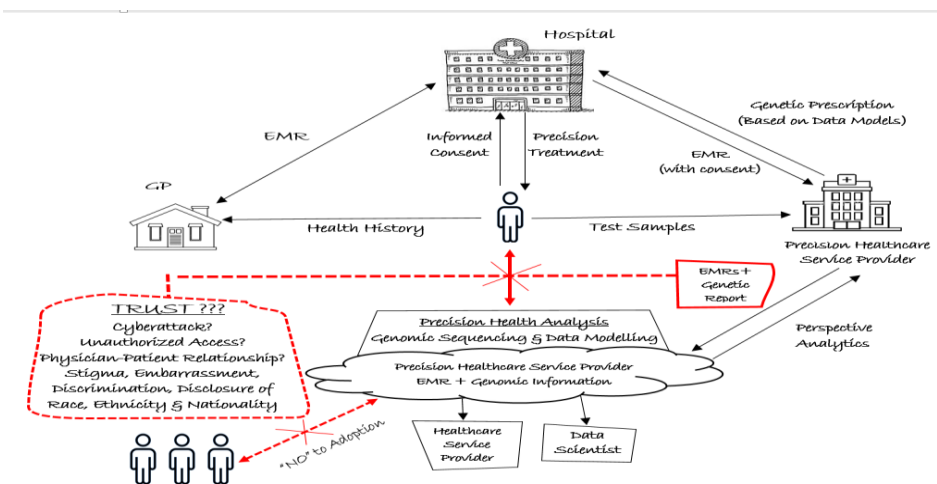


Figure 3: Generalised "Rich Picture" of the Current Problematic Situation of PHC service.

Step 3: Formulating the Root Definition of The Relevant System

This step is the unique step of SSM. The "real" world problem moves into the world of systems through this step. This step is purposed to develop the "Root Definition" of the relevant system. Root Definition means the purpose statement of the human activity system. The definition development progresses with two steps: (i) Clarifying what the system intends to transform or change and (ii) Applying the CATWOE (an acronym; customer/client, actor, transformation process, worldview, owners and environmental constraints) framework to provide the Root Definition for the transformation made. Therefore, as per the description, the Root Definition of this research is:

Development of artefacts for a PHC ecosystem based on system design principles and rules by incorporating Blockchain and emerging information technologies to ensure trust among the users.

The CATWOE framework used to develop the Root Definition is also provided in table 1.

Table 1: CATWOE of Emerging Technology Enabled PHC service.

Clients	<ul style="list-style-type: none"> ▪ Patients
Actors	<ul style="list-style-type: none"> ▪ Patients ▪ Health Practitioners ▪ Providers ▪ Technology Vendors ▪ Payors ▪ Policymakers/Regulators
Transformation	<ul style="list-style-type: none"> ▪ Artefacts for a PHC ecosystem (based on system design principles and rules, incorporating emerging information technologies)
Worldview	<ul style="list-style-type: none"> ▪ Improving practice for growing trust and uptake rates ▪ Enhancing the level of health knowledge of PHC ▪ Eliciting emerging techs for users' uptake ▪ Providing trusted, reliable healthcare monitoring ▪ Enabling precise healthcare with navigation (right time and right location)
Owners	<ul style="list-style-type: none"> ▪ Providers (Government or Non-government)
Environmental Constraints	<ul style="list-style-type: none"> ▪ Data Protection Legislation ▪ Medical Ethics – Genetic Information, Incentive Mechanisms ▪ Emerging Technologies (Currently in development)

Step 4: Building Artefacts of the PHC ecosystem

These artefacts of the PHC ecosystem were designed based on the CATWOE framework, incorporating the design principles and rules discussed in the previous section. Draw.io (A UML designing tool) was used as the diagramming tool to design these artefacts. Besides artefacts, multiple "rich pictures" were also developed to ensure a simple representation of the designed ecosystem during the demonstration. The rich pictures were developed using Microsoft Paint and included different user contexts associated with the PHC ecosystem. Refinement of the artefacts was obtained by using the same tools described to ensure rigour in design, as well as "suggestions and or comments for improvement" given in the design refinement interviews (DRIs) and design validation workshop (DVW). The strategies adopted in the DRIs and DVW are discussed next.

Step 5: Refining and Validating the Design Artefacts in the Real World

The designed PHC ecosystem artefact and sub-artefacts (i.e., dynamic modelling or scenario modelling) of the PHC ecosystem was first presented during the DRIs for informed participation. A total of 18 healthcare actors with different backgrounds (providers, policymakers, payors, technology vendors, researchers, health practitioners, and patients) participated in the DRIs. The participating actors are active professionals working in the health industry of Australia, Bangladesh, Canada, Germany, New Zealand, and the United Kingdom. The number of DRIs was not progressed further due to theoretical saturation. A design refinement instrument (structured in a questionnaire format) addressing the demonstrated artefacts was distributed among the participating healthcare actors during the demonstration. The instrument was developed using guidelines from established design research methodologies (specifically, Checkland & Scholes, 1999b; Hevner et al., 2004; Prat et al., 2015; Vaishnavi & Kuechler, 2015) to assess the efficacy and effectiveness of the designed artefacts and capable of delivering valuable user insights derived from the actors' experience and expertise. Data obtained in the DRIs were further analysed with NVivo (qualitative data analysis tool). After a multi-tier screening of the collected data, 55 comments or suggestions (including repetitive ones) were identified and analysed for further consideration in improving artefacts. The "final versions" of the PHC ecosystem artefact and sub-artefacts were next demonstrated in a DVW, using the New Zealand Healthcare ecosystem as an illustration. A Delphi panel of 20 New Zealand healthcare actors with different backgrounds (providers, policymakers, payors, technology vendors, researchers, health practitioners, and patients) participated in the DVW. The participating actors were active professionals working in Auckland District Health Board (ADHB), Canterbury District Health Board (CDHB), Ministry of Primary Industries, University of Canterbury, and a health-tech organisation in New Zealand. During the demonstration, a structured questionnaire addressing the refined artefacts' technological feasibility, economic viability, and social desirability was sent to the participating actors to obtain their valuable assessments and "comments or suggestions for further improvement" and validation. A guidebook was distributed to all the DRI and DVW participating actors to ensure informed participation. Figure 4 below depicts an example of the demonstrated artefact of the designed ecosystem. The rest of the artefact and sub-artefacts are appended as annexe A.

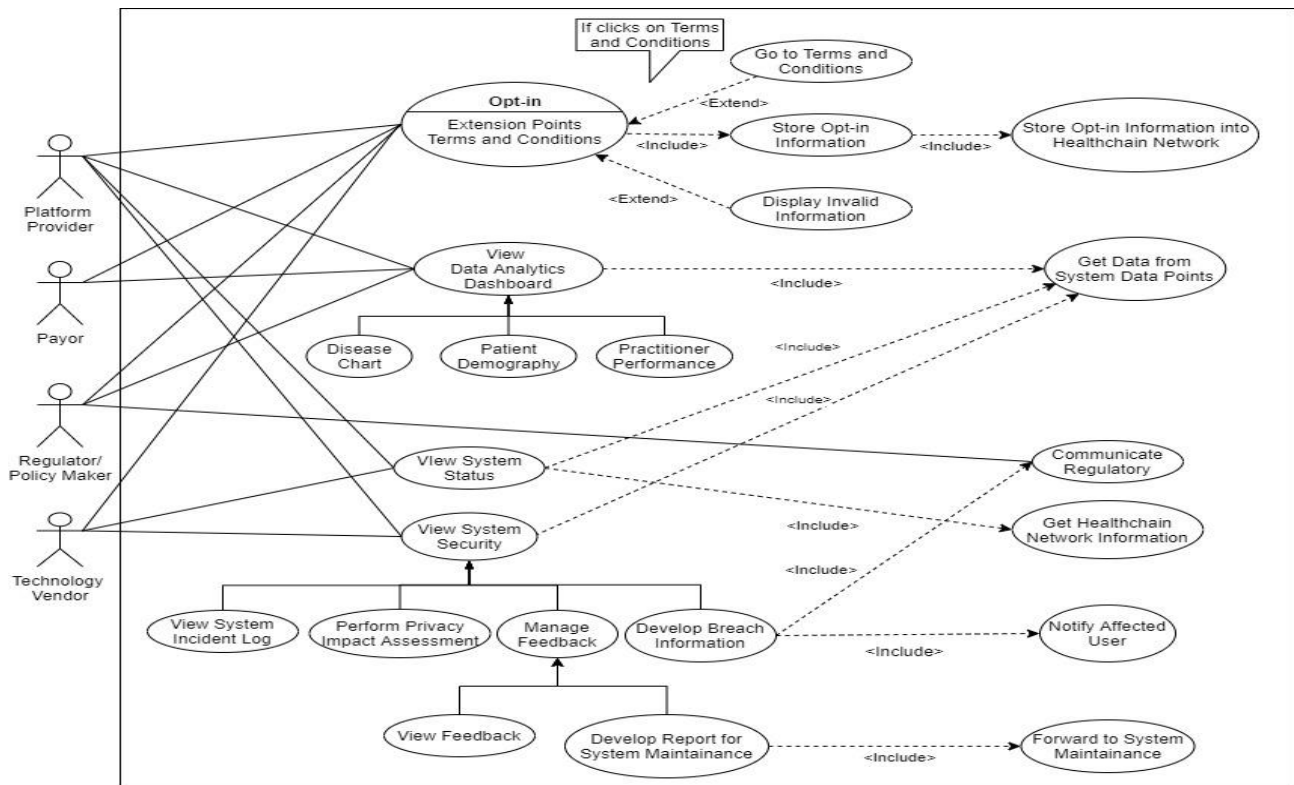


Figure 4: Use Case Diagram - PHC Service Provider, Policy Makers, Regulator, Payor, and Technology Vendor.

Step 6: Defining Changes that Overcome the Problematic Situation and may be Feasibly Implemented as a Solution

The data collected in the DRIs were screened in multiple-tier and evaluated using an assessment matrix, purposed to assess the technological feasibility, economic viability, and social desirability of the designed ecosystem with literature support. The evaluation outcome was further adopted for the artefacts' refinement, either by revisiting the previous steps, through modification or implication on the designed artefacts, or by reserving the evaluation outcome for post-system implementation. After multi-tier iteration for refinement, the designed artefacts were further demonstrated in the DVW, where a Delphi panel of experienced healthcare practitioners (actors) served as validators. Finally, the validated set of designed artefacts is now available for action to improve the current PHC service context.

Step 7: Taking Action to Improve the Real-World Situation of PHC

This step either fulfils the methodological cycle or introduces a new cycle for further research. For the exploratory research undertaken in this thesis, the artefacts of the PHC ecosystem were developed upon rigorous execution of SSM steps, ensuring best-practice system design principles, rules, and trust for its users. It is expected that the real-world implementation of this PHC ecosystem in the current lower adoption context will improve stakeholders' adoption of PHC by ensuring active user participation and engagement with the ecosystem.

FINDINGS AND CONCLUDING REMARKS

To establish an understanding of the perceived viewpoints of the participating healthcare actors and their interpreted, thematic relationship with the adopted system design principles and rules for the PHC ecosystem design, a thematic analysis (Braun & Clarke, 2006) of the data collected was determined. The participating actors with provider backgrounds shared their viewpoints on interoperability, privacy and security, user-centricity, transparency, biosensor device, and practitioner performance monitoring. The actors demand a robust application interface (API) for seamless health data interoperability, regardless of location, service provider, and biosensor device used by the patients. The actors acknowledge the need for security by design and privacy by default in system design, development, and operations. They also suggest regular privacy and security update to reduce data malpractices. For transparency, they support patient-controlled health data usage and suggest digital tracking feature(s) to ensure transparent data flow in the system. Participants also placed the need for practitioners' performance evaluation and demanded such an assessment mechanism in the ecosystem. Regarding user-centricity, the actors recommend simple, intuitive application interfaces that are important to address the patient's needs. Besides, the participating actors also inquired about the potential of contemporary biosensor devices in the designed ecosystem.

Participating researchers shared viewpoints on user-centricity, privacy and security, interoperability, and sustainability. Regarding user-centricity, they suggest simple, user-friendly, modifiable, and ubiquitous access for the users. In addition, they also demand a sentiment analysis mechanism to understand the patient's mental state before visualising sophisticated, emotion-sensitive health data to the patients, which is beyond the scope of this research and needs further research attention. They suggest implementing a multi-factor authentication mechanism for privacy and security to ensure robust security for the

ecosystem and flexible access for the User. Moreover, they acknowledged the use of Blockchain in the ecosystem and inquired about its implementation feasibility (i.e., cost). They suggest a telescopic notification feature comprising the privacy and security details to ensure transparency in privacy and security practices. They also demand a health policy review regarding patients' control over data sharing as it can be a data compromise point (e.g. data breach). In addition, they also demand regulatory concern in reviewing the existing notification distribution mechanism in the digital health settings, as the current practice demonstrates an authoritarian approach by the state-appointed policy advocates and regulators. Regarding interoperability, the actors suggest the usage of a common interoperability standard. On scalability, they suggest collaborative system design and development.

Health practitioner participants shared their viewpoints on privacy and security, user-centricity, and interoperability. They demand patient-controlled data usage to ensure privacy regarding data privacy and security. They desire adequate, uninterrupted data exchange among the stakeholders, which requires the healthcare stakeholders' implementation and usage of common interoperability standards. They also acknowledge the focus on patient needs to ensure user-centric healthcare delivery. The participating actors are firmly aware of the genomic bank, biosensor data, and EHR/EMR, acknowledge the current patient acceptance issues into PHC and demand appropriate action to address the opt-in challenge by improving patient trust. The participating actors also inquired about the competence of the proposed ecosystem in supporting sensitive physical examination (e.g. gyno intervention). From their expression, it is assumed that participating health practitioner actors still have a misconception about "Digital Applications Replacing Doctors"; despite being familiar with its scope, application, capability, and context for years. In the contemporary healthcare setting, where digital transformation is disruptive, it is a challenge to make them understand that the emergence of digital health is to provide data support to health practitioners to ensure efficacy in healthcare services and delivery, not replace them with technology. This vague conception is a challenge for expanding digital health and expect to be improved in the coming days. Nevertheless, the remote intervention of such type (sensitive) is subject to user consent, digital health literacy, overall technology infrastructure, and regulatory guideline (subject to availability). The PHC ecosystem is designed to support remote intervention with video consultation, EHR/EMR, Treatment Plan (periodically executed by the proposed system with patient consultation), clinical taxonomy, genomic profile (subject to availability), and digital twin (based on biosensors data from wearables, can be a generic type or health practitioner advised). The digital intervention of such type (sensitivity) is typically determined with user consent and depends on the health practitioners' competence in treating such. Therefore, the digital intervention of such kind (sensitive) with the demonstrated ecosystem is possible and significantly depends on health practitioners' and patients' experience, technical support and usage (at the user end), user consent (prior intervention), and regulatory approval.

Technology vendor actors shared their viewpoints on monitoring practitioner performance, privacy and security, interoperability, and scalability. They demand solutions that will monitor the practitioners' performance while treating patients. Regarding privacy and security, they require privacy by default in the ecosystem and suggest including additional security mechanisms (i.e., Blockchain) besides conventional privacy and security implementations. They acknowledge the data exchange challenge in LMICs (low-middle income countries) as different interoperability standards are in practice. Furthermore, many countries have laws that prohibit storing and sharing identifiable healthcare data offshore. Therefore, they suggest adopting a common interoperability standard for the ecosystem. Regarding scalability, they suggest strategic ecosystem development, including affordability in principle.

Patient participants shared their viewpoints on user-centricity, privacy and security, transparency, and interoperability. They demand simple and user-friendly access focused on patient needs regarding user-centricity. The actors are concerned about the need for data privacy and security and suggest implementing robust privacy and security mechanism (i.e. encryption schemes) in the designed ecosystem. They suggest prior "notification and consent" in practice regarding system and security updates to ensure transparency to every User. Furthermore, the participating actors strongly recommend maintaining minimum data quality standards to support functional data interoperability among the stakeholders.

Participants with policymaker backgrounds shared viewpoints on privacy and security, transparency, biosensor device, data aggregation, and patient engagement in PHC. The actor acknowledges the need for privacy and security in every possible aspect of healthcare data (collection, storage, analysis, and sharing) so that it does not harm the patients. Data should be dealt with patients' prior consent to establish transparency. Expansion of biosensor devices and their usage should be on rollout and context-specific. Strategic imposing of all these mentioned can potentially impact patient engagement in PHC. Furthermore, all these are potential for data aggregation and are significant for healthcare policy development and improvement.

Due to the ongoing COVID-19 pandemic, participating healthcare actors underwent a stressful work cycle in terms of work commitments and workloads. Hence, scheduling DVW on a specific date and time was challenging. In these circumstances, the DVW was conducted in a virtual and asynchronous mode. The demonstration was pre-recorded and distributed among the participants to join at their convenience. A participation link was developed using Google Forms, with consent information, a participant profile, a video overview of the New Zealand PHC service platform, and a design validation instrument [available from the lead author upon request]. The design validation instrument was used to assess (on a 0 to 10 Likert scale) the social desirability, technological feasibility, and economic viability of the set of sub-artefacts developed during the Design Refinement Interviews and submitted in the Annex to this paper. 85% of the participating actors (17 out of 20) rated between 7

to 10 on the social desirability and economic viability of demonstrated PHC ecosystem. Furthermore, 90% of the participating actors (18 out of 20) rate between 7 to 10 on technological feasibility. We may claim face and construct validity.

A few suggestions and comments were also received from the participating actors. Among those, a notable one suggested "multi-tier patient consent" as a requirement during genomic information accessed by the health practitioner. The ecosystem's existing design can support such needs through its notification management without making any design refinement. By design, the system notifies the patients of every activity related to their health data, including consent requests. Therefore, by default, the system will inform the patient about the request made by the health practitioner and ask for consent before approving the genomic information request. It empowers patients' control over their health data usage and motivates active engagement with the ecosystem. The ecosystem visualises genomic information to the patients on request only. It is purposed to optimise the operational and maintenance cost of the ecosystem, as understanding genomic information requires high-level knowledge of medical terms and education and may be counterproductive (e.g. frustrating, demotivating) in patient engagement.

As an agenda for further research, the following are suggested. The artefact and sub-artefacts of the PHC ecosystem are now ready for functional implementation. Therefore, one course of action should be developing a real-world system. Considering the economic viability, implementing the designed ecosystem should be cost-effective in cloud computing infrastructure (Reynoso, 2017). However, due to the sophisticated health data, a such implementation should be conducted with regulatory concern and approval.

Further research on health data privacy and security policy development is also required to accommodate the disruptive information technologies within the digital health domain. The regulators can strategically monitor the operational services and exercise enforcements when needed (Sharma et al., 2019). Furthermore, a significant gap in qualitative research in PHC requires further research attention. A recent study shows that multiple qualitative data repositories are currently under development (Myroniuk et al., 2021), previously known under the domain of quantitative research. These initiatives are significant, but the efficacy of these repositories in qualitative PHC research is yet to be explored. Further PHC research, therefore, should incorporate these data repositories to determine qualitative research focusing on explainable AI, data standards for biosensor devices, and affordable blockchain solutions for storage, privacy, security, interoperability, and user-centricity. It will enable global collaboration for interdisciplinary PHC research and contribute to the targeted sustainability of healthcare and the well-being of humanity.

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ANNEX A: Design Artefact and Sub-Artefacts of the PHC Ecosystem.

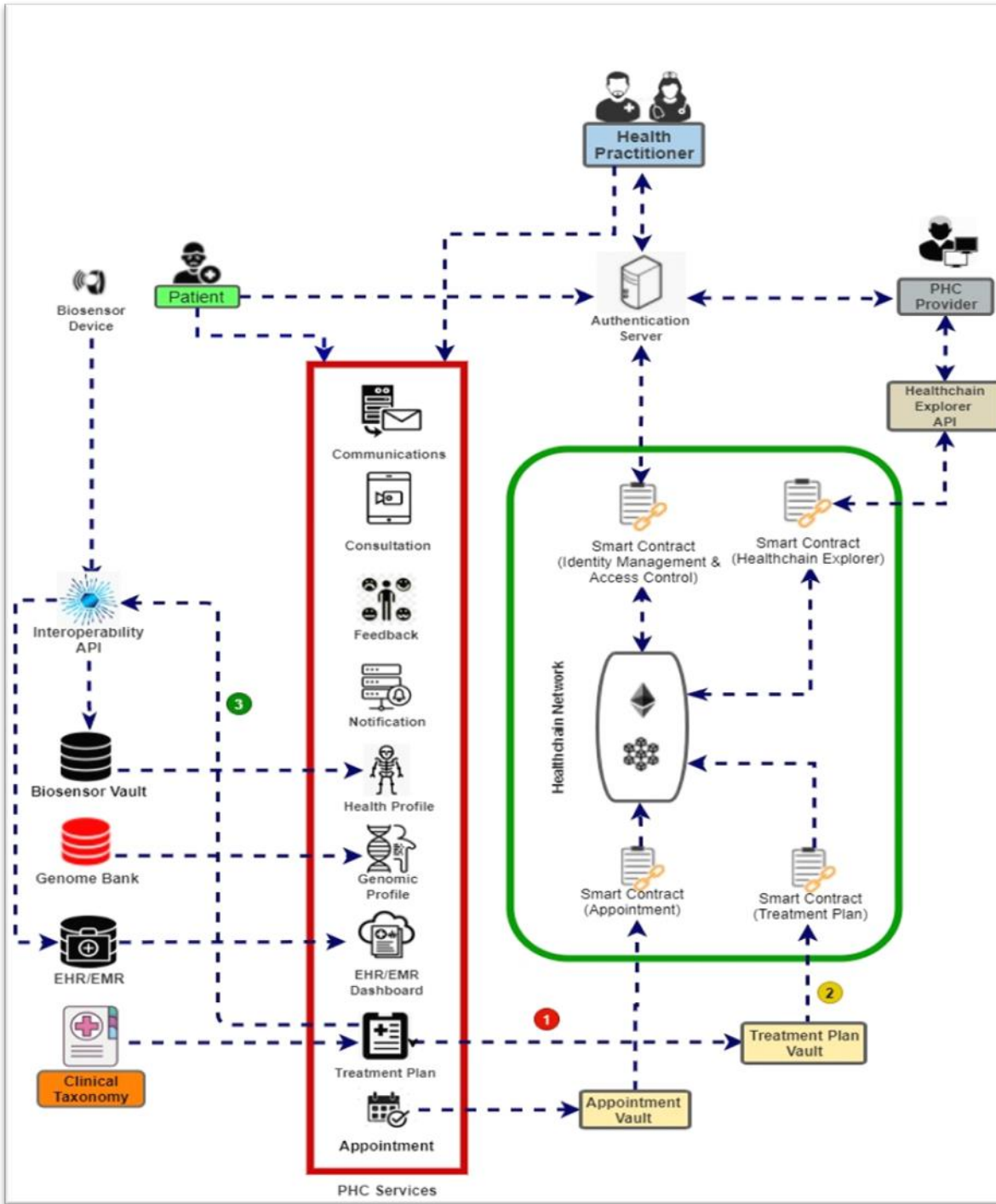


Figure 5: System Architecture of the PHC Ecosystem.

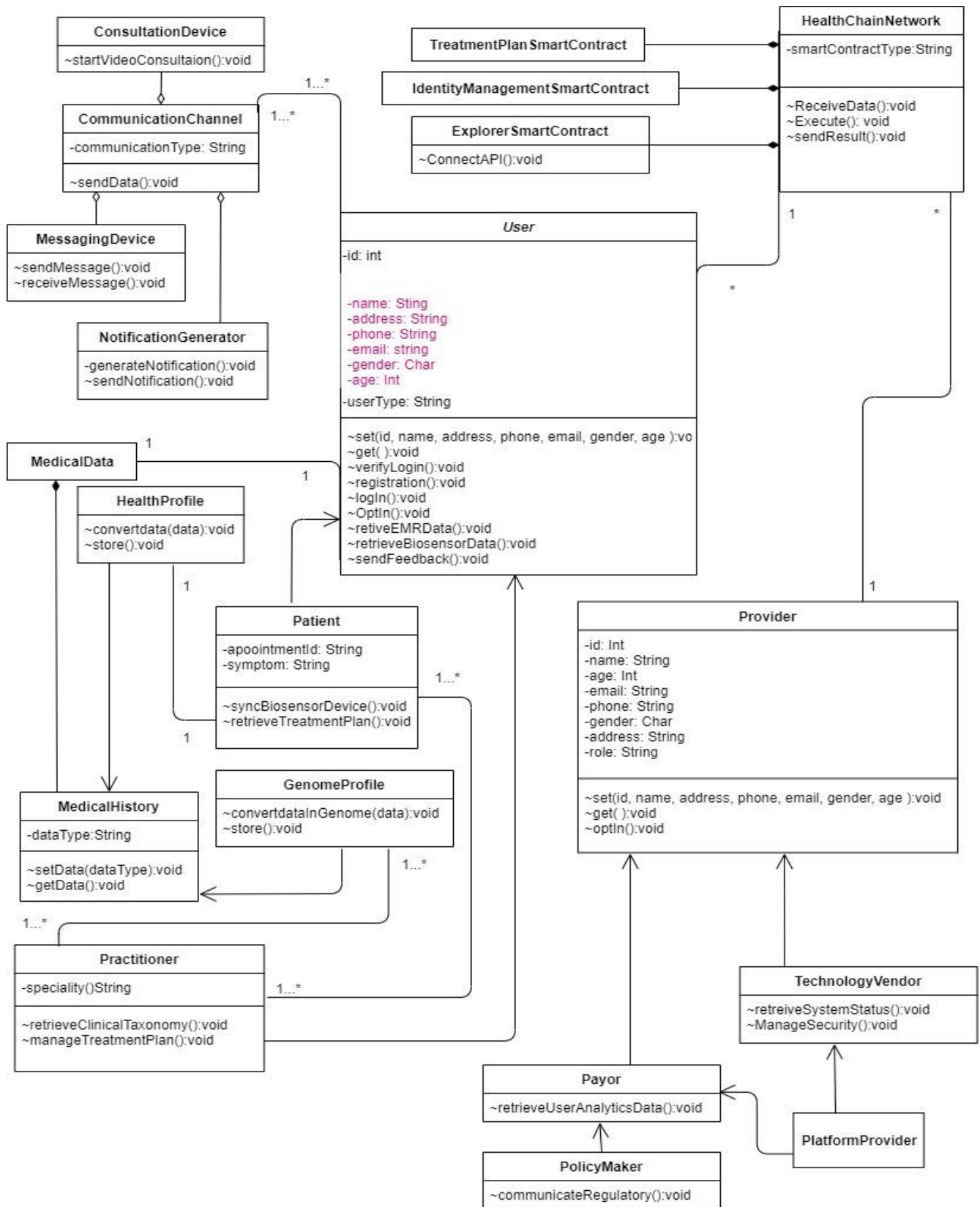


Figure 6: Class Diagram of New Zealand PHC Ecosystem.

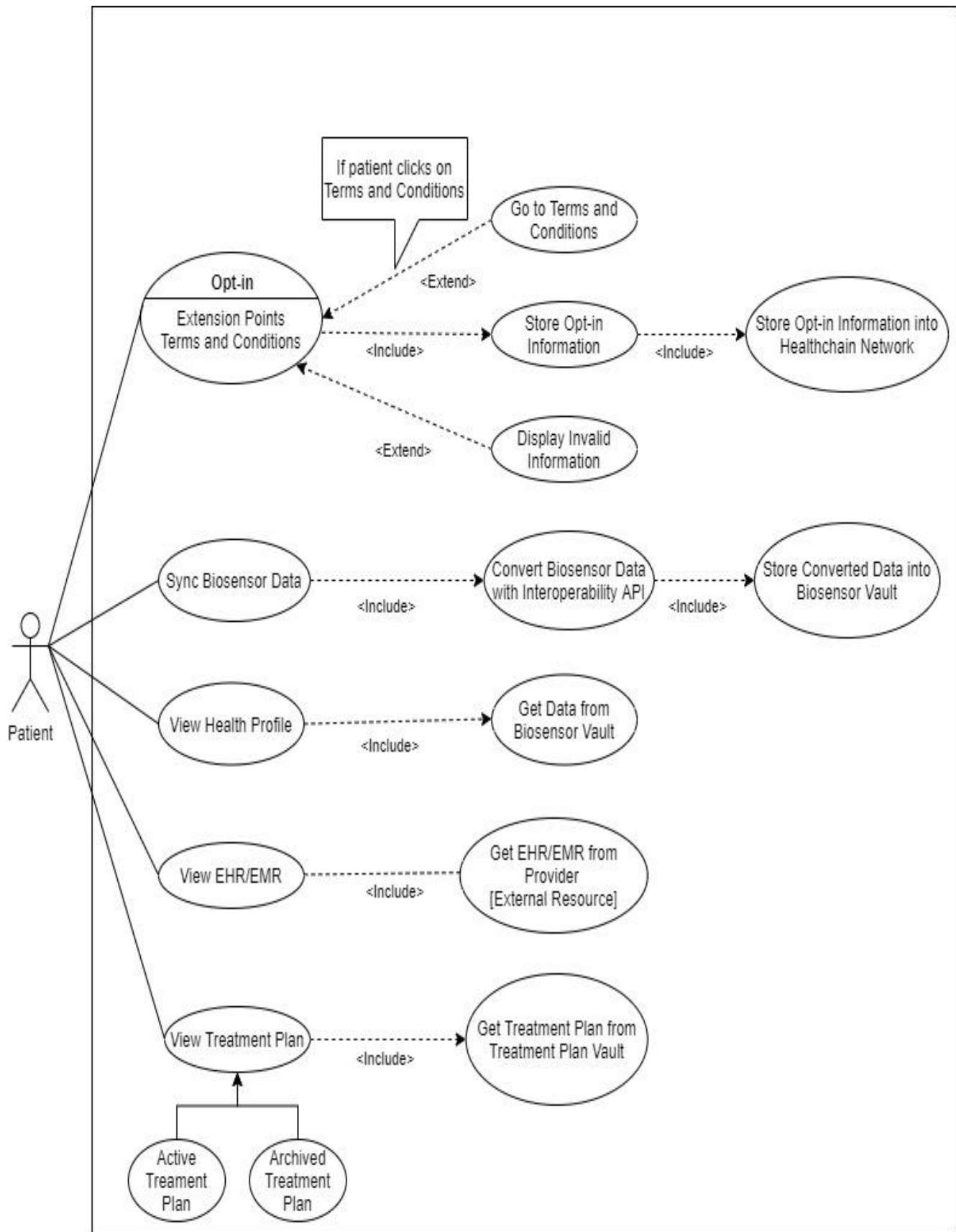


Figure 7: Use Case Diagram - Patient.

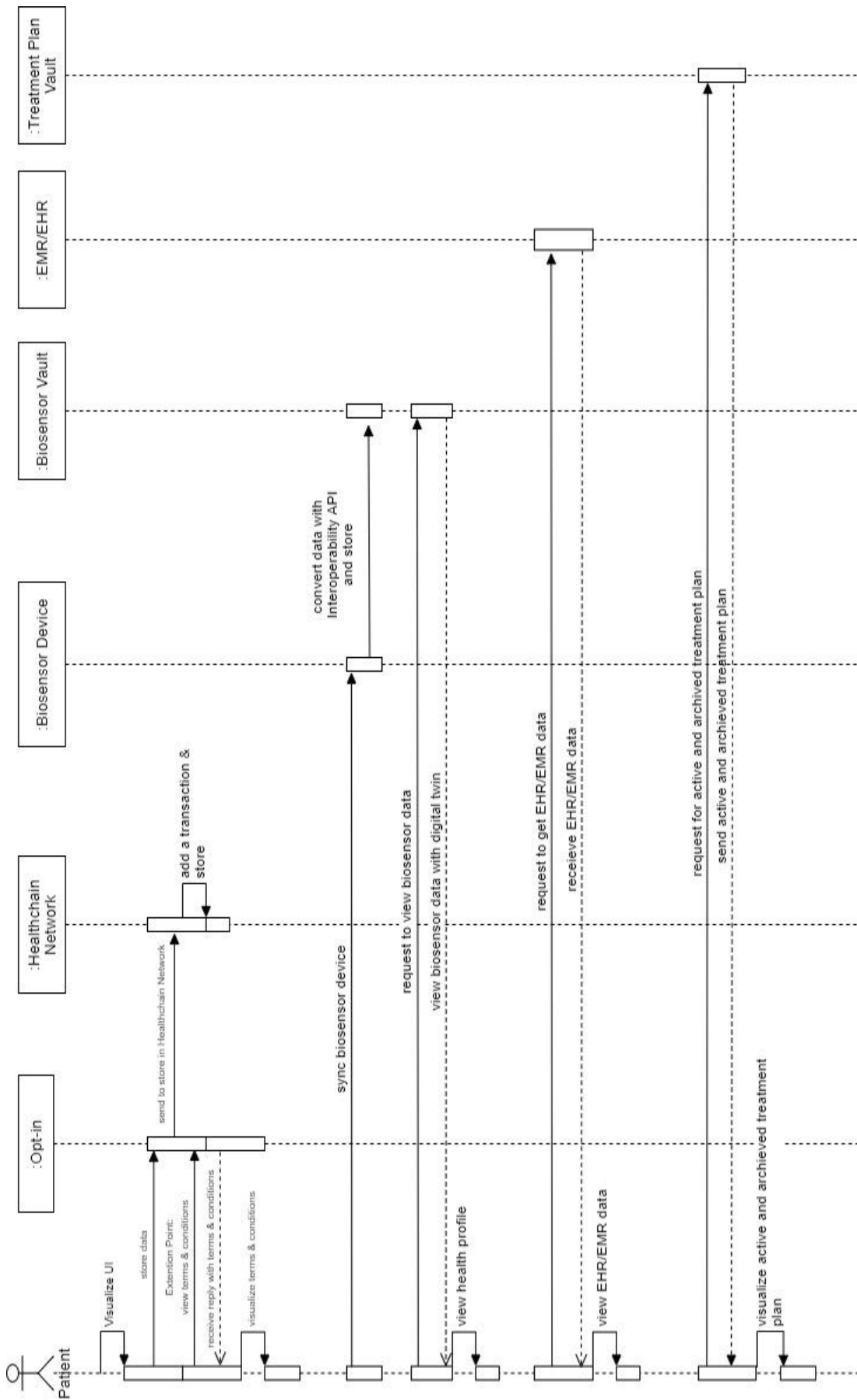


Figure 8: Sequence Diagram - Patient.

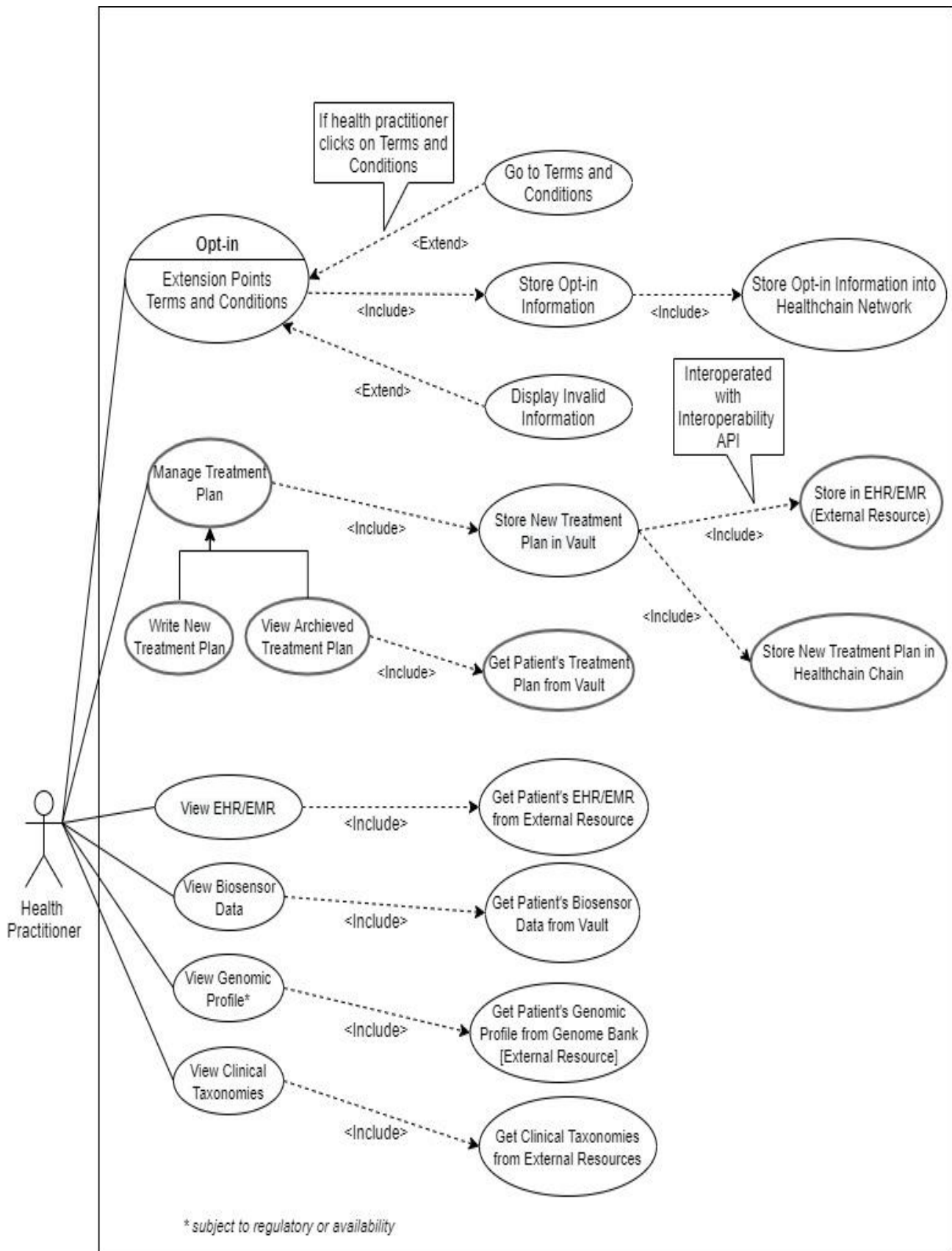


Figure 9: Use Case Diagram – Health Practitioner.

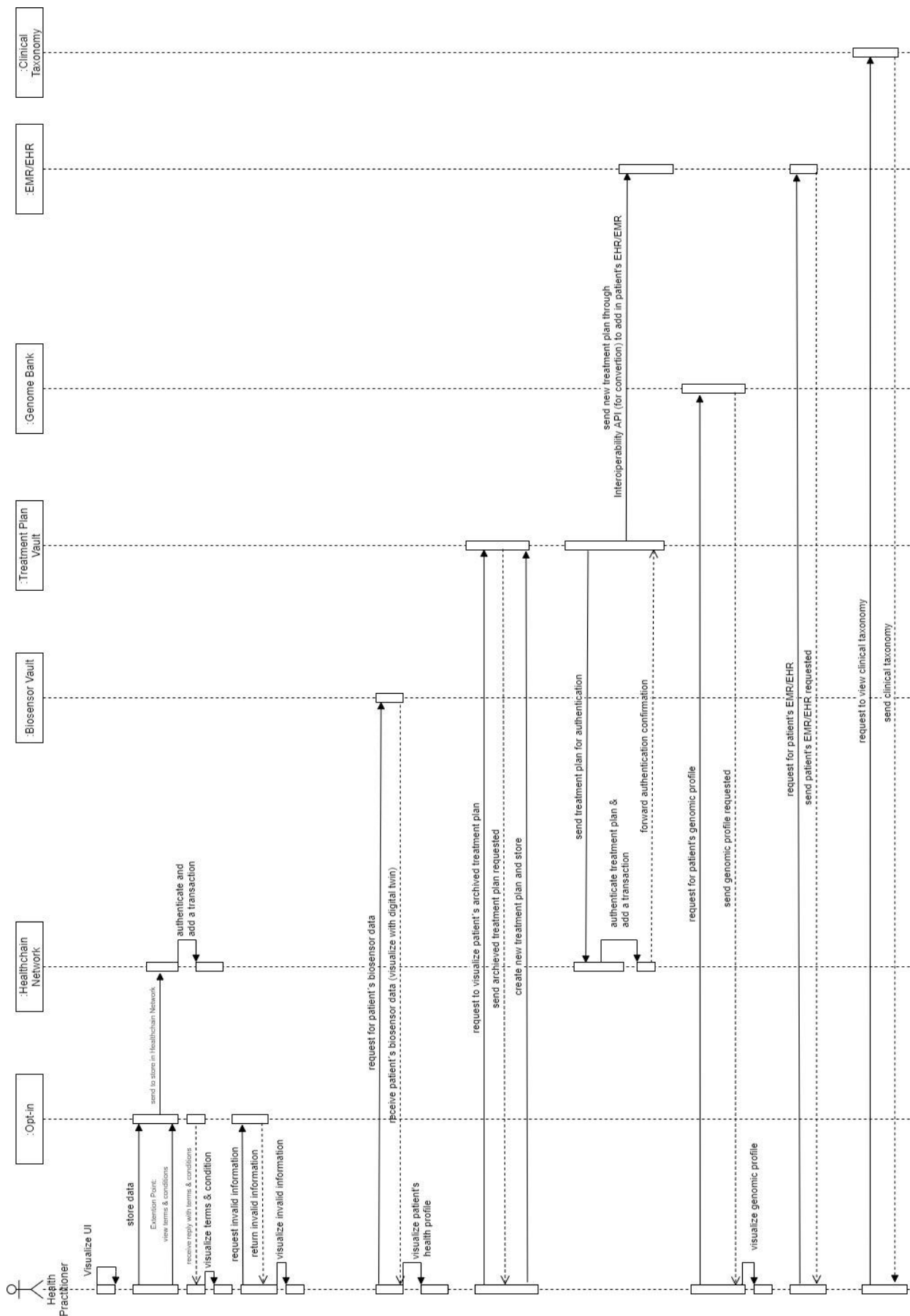


Figure 10: Sequence Diagram – Health Practitioner.

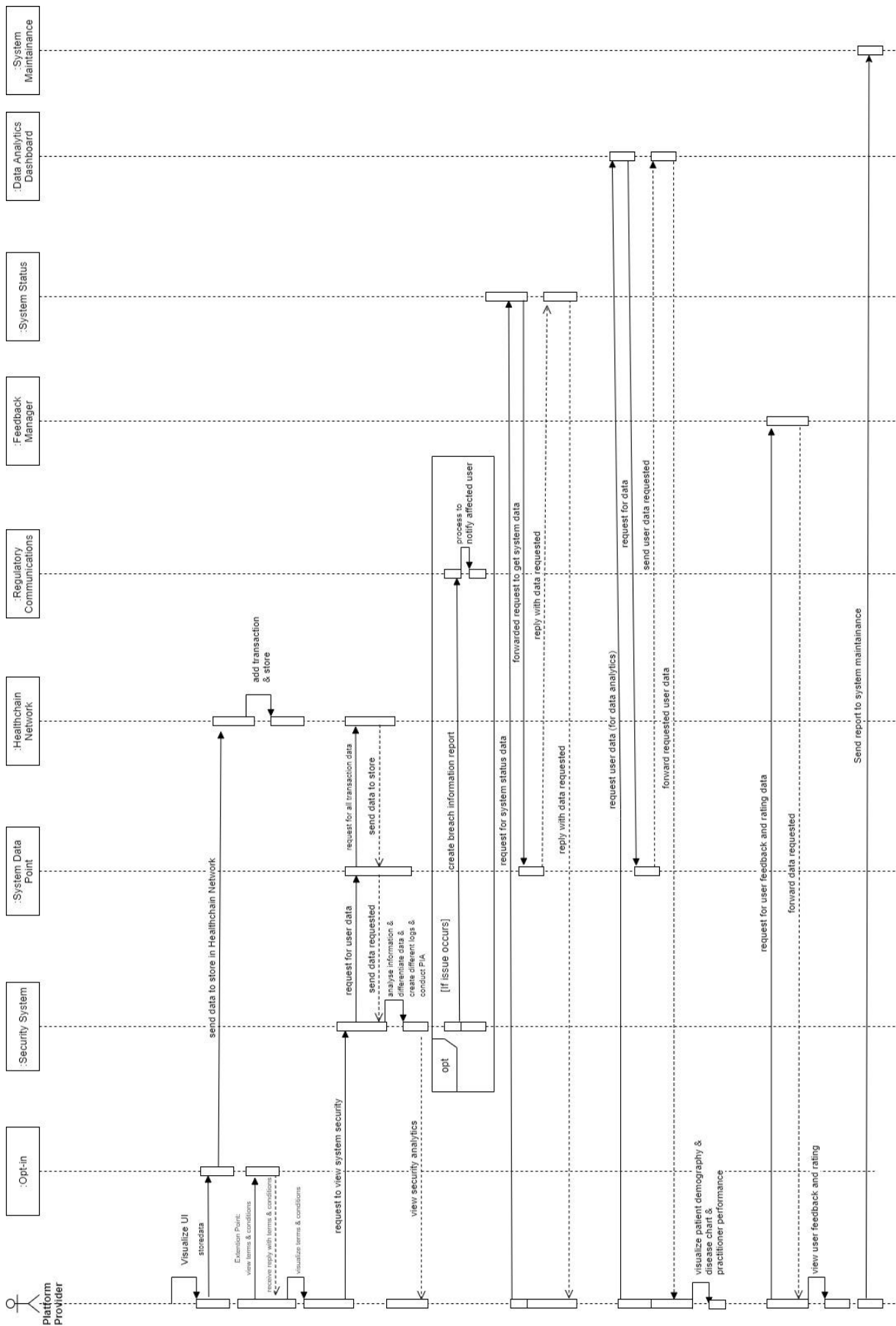


Figure 11: Sequence Diagram – PHC Service Provider.

Sustainable competitive advantage in entrepreneurial software firms in Pakistan: Establishing a conceptual research framework

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ABSTRACT

Software firms are expanding within increasingly-competitive domestic and global marketplaces. Registered software firms in Pakistan seek new ways to better compete and remain as sustainable competitive entities. Such firms operate entrepreneurially, and remain subject to dynamic digital and globally-emerging changes. A literature review establishes constructs, conceptual relational hypothesis pathways, and an overall (testable) research framework for software firms in Pakistan. The framework is likely useful when modelling for improvements contributing towards sustainable competitive advantage shifts.

Keywords: Entrepreneurial orientation, knowledge creation, absorptive capabilities, competencies, sustainable competitive advantage, software development.

INTRODUCTION

Achieving long term 'sustainable competitive advantage is becoming harder within software industry in Pakistan as the number of new SECP registered software firms continues to increase (*source* <https://moitt.gov.pk/>) from 395 in 2014 to 581 in 2016 to 1452 in 2018 to 2826 in 2020. Currently there are over 3000 software firms registered. Pakistan software firms create useable code and coding products across software technologies, new initiatives, distributive solutions, and new software. However they also face direct and indirect competitive pressures from freelancing software developers with Pakistan being the third most popular freelancing software country, and ranking fourth in global freelancer growth (*source* <https://moitt.gov.pk/>). Thus, although the software industry remains a sizeable, highly competitive, and profitable business domain it remains under cost constraint pressures, Pakistan software firms remain in continual pursuit of sustainable competitive advantage solutions.

The State Bank of Pakistan says Pakistan currently exports over \$700M worth of software products. In FY2019- 20 Pakistan software firms generated \$831M in revenue this grew to \$1.9B during FY2020-21. In FY2020-21 software imports and local development of software for domestic totalled \$1.2B. Currently the industry generates around \$3.5B in revenue (USA International Trade Administration website). However forty five per cent of their projects has delivered below target sales returns. This was partly due to COVID-19 restrictions necessitating reducing software completions, and in some cases, partly due to firm shutdowns and consequent lost business opportunities. Today yet another software firm sales complication is the external requirement to deliver additional democratized connectivities capabilities, and further global universal system functionalities.

Pakistan's software sector has a mix of local application developers, freelancers, and IT firms working primarily in domestic and corporate applications developments. Most high-end companies focus on enterprise resource management and customized solutions for specific firm or industrial sectors. However, some local companies and freelancers are focused in the online social media space working particularly in the 3G and 4G domain to deliver consumer applications based on Android or Apple platforms, website development, e-wallets/payments, e-commerce, and online gaming. Foreign software firms engage either local distributors or their own technical/developer/support teams (Pakistan - Country Commercial Guide, Computer Software (2022)).

Pakistan government levels prioritize growing the IT and software industry. They offer incentives including incentives include: (1) 100% equity ownership, (2) IT exports revenue income tax exemptions, (3) 100% profit repatriation, (4) tax break for venture capital funds (before June 2024), (5) 30% accelerated depreciation on computer equipment, (6) State Bank of Pakistan (SBP) permission for banks to open Internet Merchant Accounts, (7) availability of instant, reliable, and high-speed internet connectivities. Thus with government support, plus domestic and international demands growing, the software industry in Pakistan is targeting sustainable competitive advantage growth strategies. For example, in 2022 advances in broad mobile

wallet usage, and cheap smartphones, are together helping Pakistan's e-commerce sector generate over \$1.5B in revenue (Pakistan - Country Commercial Guide, Computer Software. (2022).

Software firms are by nature entrepreneurial in their orientation. They pursue and develop new coding solutions. They use their knowledge in creative ways to generate working solutions to new, emerging, or potential problems. This approach to problem solving initiates the firm's engagement of its relevant capabilities into a collective absorptive system specifically targeted to meet the new coding solution requirements. This may involve guesswork, trial and error, design science, experimentation, exploitation, extension, and eventually collation into a useable product suite, offering ongoing sustainable competitive advantage solutions.

Hence this study pursues understanding around *'how the entrepreneurial orientation and the knowledge creation of Pakistan software firms can help them action their absorptive capabilities and use these components to deliver ongoing sustainable competitive advantage.'* The Pakistan software firm study explores dimensions of Entrepreneurial Orientation and Knowledge Creation across the industry, and how these engage firm Absorptive Capabilities to influence and help build Sustainable Competitive Advantage. It presents these as a framework model and as an introduction to the authors' ongoing research. It also identifies key limitations of enhancing firm performance in software firms in Pakistan.

LITERATURE REVIEW

This section reviews previous literature on entrepreneurial orientation (EO), knowledge creation (KC), absorptive capability (AC) dimensions, and sustainable competitive advantage (SCA). It then delivers a theoretical framework for delivering SCA within the software industry in Pakistan.

Knowledge Creation

KC has a theoretical basis regarding the business domain. It directs towards maintaining firm sustainable competitive advantage. Within the business domain, KC has 'organizational' or 'individual' connotations. KC empirical and/or theoretical firm studies around Nonaka et al.'s (1995) theory suggest knowledge and its generation is a resource leading towards firm sustainable competitive advantage. More recently theory, process and knowledge have expanded into diverse topics, such as absorbent capabilities, organizational learning, leadership styles, cultural aspects, and entrepreneurial contribution (Agarwal et al., 2022). KC is also a multi-component new knowledge acquisition construct, and Oyemomi et al., 2019 and Tootell et al. (2020) suggest it enhances firm performance and sustainable competitive advantage.

Knowledge

Knowledge is a skills and cognitions set that may apply to solve a firm practical or theoretical problem (Kim et al., 2022). External knowledge is globally acquired information and/or other sourced data (Roper et al., 2017). Internal knowledge is created by workforce individuals, systems networks, and/or beliefs (Meyer & Sugiyama, 2007). However new knowledge often blends internal knowledge components with present firm information and external knowledge acquisitions (Gourlay, 2006). Some suggest knowledge can classify as either tacit knowledge involving individual actions, experiences, procedures, values, and/or emotions (Nonaka et al., 2014). Tacit knowledge is most challenging and sometimes non-verbal (Agarwal et al., 2022). In contrast explicit knowledge is stored in hard assets -like documents, graphs, booklets, and manuals (Park et al., 2015) or extracted information from memory (Nonaka & Konno, 1998). Explicit knowledge is often technical or academic or codified knowledge (Lichtenthaler, 2016).

Software Industry Knowledge Creation

Software firms encounter opportunities and pressures within modern dynamic, technological and economic environments (Huang & Chen, 2022). In today's digital economy, knowledge is critical to delivering sustainable competitive advantage, but it is extensively spread across the global and digital marketplace. Hence, firms strive to create new strategic knowledge (Flor et al., 2018). Global, internet-connected, technological progression has reduced the digital differences between geographically-located knowledge sources. Hence, software developers pursue new knowledge horizons seeking further firm sustainable competitive advantage (Yi et al., 2021). Such pursuits can interconnect and promote firm innovativeness (Ferraris et al., 2017). Consumer relationship connectivities can also interlink firm R&D processes (Papa et al., 2018). Here, software firms pursue valuable new knowledge, conduct market-related activities, retain marketplace position, increase sales, deliver customer service, improve performance, and co-create products (Roper et al., 2017; Santoro et al., 2018) within changes in the knowledge-based economy (Tura et al., 2019; Ulas, 2019), whilst generating positive firm performance-related changes and a SCA (Abbas, 2020; Bag et al., 2021; Gangi et al., 2019; Papa et al., 2020). Thus, KC remains a strategic competency for the firm (Abbas & Sağsan, 2019), and is a likely precursor supporting firm capabilities and the firm's strategic business framework (Mardani et al., 2018).

Measurement of Knowledge Creation in Software Firms

Processes, techniques, and tools to deliver new knowledge into usable formats and participate in (SCEI Model) processes are called KC (Nonaka et al., 2000). Four different links exist between explicit and tacit knowledge. Several research studies have indicated KC is beneficial to hi-tech firms - as KC can support individual firm quests for sustainable, competitive advantage (Tootell et al., 2020).

KC captures both 'know-how' and synthesis. It supports integrating developing new ideas into firm-enriching and actionable solutions (Gourlay, 2006). KC can be a five-step KC process (share experience to explicit knowledge to justifying concepts to prototyping to cross leveling knowledge) (Song, 2008; Song et al., 2011), or it can be a three-step process (generating, then codifying, then transferring) knowledge (Barley et al., 2018).

KC involves the introduction of new knowledge into the firm (Gamble, 2020). KC codification captures/represents knowledge used repeatedly by a firm or its workforce. KC shares and utilizes components according to available firm absorptive capacities (Barley et al., 2018). KC, in part, arises from general knowledge management. Previously, KC was often tacit knowledge focused, but currently it is more a continuous firm workforce/individual procedure that is often applied and amplified whilst integrating existing firm knowledge systems (Von Krogh et al., 2012).

KC processes and interactions between tacit and explicit knowledge transform knowledge type mixes into firm-wide knowledge. For example, the SECI KC model constantly interchanges and converts firm knowledge, and then dynamically sequences relevant delivery processes (Nonaka et al., 2006) towards firm SCA solutions. New opportunities emerge when exploiting knowledge interactions and dynamic-workforce groupings into latest knowledge sharing (Chatterjee et al., 2018). The SECI KC model of knowledge conversion and transformations between explicit and tacit knowledge follows natural, rational, purposeful procedures (Andreeva & Ikhilchik, 2011) – captured as four tacit and explicit knowledge steps (socialization (tacit collation), externalization (converting tacit to explicit), combination (grouping explicit forms), internationalization (reassigning and recombining present knowledge into new knowledge). This study borrows KC measures from Papa et al.,'s (2018) four SECI segment measurement approach - as these capture KC and encompass related dimensions of knowledge management (knowledge transfer, documentation, and acquisition capacities) as tacit and explicit knowledge (Mehralian et al., 2018). It measures KC externally as a (1) new value-adding process, (2) new idea complementing current research, (3) significant unique data capture, (4) unique organizational opportunity, and internally as a (1) beneficial technologies transfer, (2) new problem solution, (3) hard-to-imitate competency, and (4) firm enriching prototype.

KC and Sustainable Competitive Advantage

Knowledge is critical to actioning firm performance capabilities (Chung et al., 2019). High-tech software firms need adequate knowledge resourcings to remain competitive (Cavaleri & Shabana, 2018). Currently knowledge remains a critical resource in delivering a sustainable competitive advantage (Bolisani & Bratianu, 2017, Tura et al., 2019). KC is a procedural process that continually incorporates and transfers tacit and explicit knowledge (Park et al., 2015). It builds new knowledge and delivers (1), new methods (2) new solutions to solve problems, (3) enhanced performance, (4) innovative work approaches, (5) novel concepts, (6) new products, and (7) new ways of reasoning (Crescenzi et al., 2016). As KC develops, novel and valuable ideas and solutions in firms. Thus, firms holding a constant competitive edge likely create additional wealth, value, and sustainable growth (Omar et al., 2016). The conversion of new knowledge into auctioning capabilities permits a firm to be more productive and efficient whilst also reducing costs and increasing speed of developing/introducing new products (Ichijo & Nonaka, 2007).

Studies indicate firms exploiting advances in KC to build additional or better capabilities, can successfully develop SCA (Cuevas-Rodríguez et al., 2014; Nonaka et al., 2000, Arnett & Wittmann, 2014; Ichijo & Nonaka, 2007; Mahdi et al., 2019) to surpass competitors (Spraggon & Bodolica, 2017). Thus, this study hypothesizes (H1a-d) 'KC is an initiating competency construct in the build of actioning ACs through its constructs blocks (acquisition, assimilation, transformation, exploitation). It further hypothesizes (H11) that KC contributes towards enhancing SCA.

H1a: KC positively influences acquisition

H1b: KC positively influences assimilation

H1c: KC positively influences transformation

H1d: KC positively influences exploitation

H11: KC positively influences SCA

Entrepreneurial Orientation

EO is well-studied (Covin & Wales, 2019). A firm's EO engages when pursuing entrepreneurial activities and endeavors (Jeong et al., 2019). EO encompasses practices, procedures, decision-making and problem-solving activities. These can encompass a novel product, technical innovation, new procedure, or different business model precursor, with each possibly influencing SCA (Altinay et al., 2016). Entrepreneurship literature suggests EO (1) helps knowing why, and how, various firms enlist new ways to develop/reinvigorate/improve over-time, (2) occurs via sets of variable items, or a continuous construct- thus offering more than one dimension to frame the firm, and (3) is unique from other entrepreneurial constructs - like entrepreneurial philosophy, climate, and others. Thus, EO is likely a fundamental entrepreneurial process component (Rodrigo-Alarcón et al., 2018).

Although greater EO generally provides better performance (Alegre & Chiva, 2013; Brettel et al., 2015; Campbell & Park, 2017; Jeong et al., 2019) an EO firm pursues efficient decision-making (Lumpkin & Dess, 1996). This study views EO as causal influence on firm performance and growth, and linking into relative performance diversity among various firms (Gaur & Delios, 2015), but recognizes EO should capture a range of variables across relevance, position, and impact in emerging SMEs markets (Jeong et al., 2019). EO also effects other constructs, and other stages of firm development (Covin & Wales,

2019). Hence for SMEs – like software firms, the literature supports EO as a suite of capacities measures (proactiveness, risk taking, innovativeness, competitive aggressiveness, autonomy) (Mullens, 2018, Gauthier et al., 2021, Mostafiz et al., 2021, Omisakin & Adegoke, 2022).

Proactiveness

EO proactiveness is a will to detect and seize innovative market opportunities (Covin & Wales, 2019), and be (1) early in the marketplace, (2) fast/active to develop products, (3) adopting new processes/services, (4) effective in searching for new industry opportunities (Kohtamäki et al., 2019).

Proactiveness is ‘acting’ instead of ‘reacting’ (Kraus, 2013) by capturing opportunities, observing new industry trends, and foreseeing the future requirements of clients (Lomberg et al., 2017). A proactive firm can be a marketplace pioneer (Filser & Eggers, 2014). In SMEs higher proactiveness pushes increasing growth and prosperity (Corrêa et al., 2022) by directing resources towards creating new products/services, capturing both opportunities, and winning new marketplaces (Song et al., 2017). Proactiveness inspires firm R&D activities (Lee & Roh, 2020), and reconfiguring resources into innovation and towards firm SCA (DeTienne et al., 2015). Thus, literature suggests EO proactive approaches push towards adopting new innovative techniques/technologies, delivering efficient performances/activities (Kreiser et al., 2010), and providing solutions desired by the marketplace. This relationship forms hypothesis (H4a-d). It further hypothesizes proactiveness as contributing to the required sustainability of the firm (H14).

- H4a: Proactiveness positively influences acquisition
- H4b: Proactiveness positively influences assimilation
- H4c: Proactiveness positively influences transformation
- H4d: Proactiveness positively influences exploitation
- H14: Proactiveness positively influences SCA

Acquiring and retaining new knowledge is important in software industries provided it’s utilized and resourced into pathways developing new processes/products/services. Proactiveness adds scope to firm innovation developments and operational performance advances (Lee & Roh, 2020). To study proactiveness in software firms we borrowed measures from Alshanty and Emeagwali, (2019).

Innovativeness

(Malerba and McKelvey (2020) note innovativeness is recognized within EO. Innovation has many forms – like product, market, service, process, and/or technological innovation. As a ‘creative destruction: process’ launching new processes/products/services and disturbing marketplaces (Lee & Roh, 2020), innovativeness initiates/promotes/acquires/produces/fosters new knowledge that adds to creation of new products/services, and to optimally and profitably utilizes resources/knowledge reservoirs (DeTienne et al., 2015). Innovativeness is a key EO dimension (Tresna & Raharja, 2019). Literature is still clarifying if EO innovation is an input or output component (Baregheh et al., 2009). Innovation considerations, like marketplace and product deliverables are considered outcome measures, whilst process and behavioral innovation capture underlying factors facilitating product and marketplace innovation. This study considers innovation a part of EO, and not as an innovation outcome. Hence this study hypothesizes (H2a-d) innovation as an important initiating construct in building AC through its constructs blocks (performance, services, intelligences, and applied risk taking). It further hypothesizes innovation as contributing to the required sustainability of the firm (H12).

- H2a: Innovativeness positively influences acquisition
- H2b: Innovativeness positively influences assimilation
- H2c: Innovativeness positively influences transformation
- H2d: Innovativeness positively influences exploitation
- H12: Innovativeness positively influences SCA

Within the software industry, innovation is typically an iterative procedure of technology and process invention that initiates new services and marketplaces. It initiates processes including development, creation, product, and marketing considerations – these may offer firm performance successes and SCA. However, technological knowledge within the firm, and in-house R&D, remain important aspects of innovativeness. (Canzano & Grimaldi, 2012). To gauge innovation in software firms we adapted measures from (Alshanty & Emeagwali, 2019).

Competitive Aggressiveness

Competitive aggressiveness describes firm tendency to intensely and immediately challenge rivals/competitors, and either attain entry, or develop differentiated performance competencies within the industry (Yaro et al., 2020). It represents the firm motive to block rival/competitor actions (Obi et al., 2021) by ‘thinking-outside-the-box’ (Cho et al., 2021). This specific planned proactive/reactive preparedness (Habib et al., 2020) helps aggressively drive towards a performance level, and successfully compete within marketplaces (Sutejo & Silalahi, 2021). It often follows a cost and price format (Porter, 2008), sometimes involving previously unachievable consumer options at lower prices, and occasionally accepting reduced profits (Stambaugh et al., 2020). Alternatively, competitive aggressiveness can increase where pace/frequency of rival attacks is higher (Crick, 2020) – such as in alliances and mergers situations (Panjaitan et al., 2021). Hence, competitive aggressiveness is measurable via firm attitudinal awareness, combined with available proactive/reactive capacities (or skills) to quickly generate

desired change. Thus, competitive aggressiveness also links into the firm's ACs to implement change. Overall competitive aggressiveness relates to other EO constructs and forms the hypothesis block of H5a-d. Further, it also links to the delivery of a sustainable marketplace (SM) and a SCA for the firm. This is hypothesized as H15.

- H5a: Competitive aggressiveness positively influences acquisition
- H5b: Competitive aggressiveness positively influences assimilation
- H5c: Competitive aggressiveness positively influences transformation
- H5d: Competitive aggressiveness positively influences exploitation
- H15: Competitive aggressiveness positively influences SCA

Awareness, motivation and capabilities determines level of competitive aggressiveness in software industry. Software firms gain competitive aggressiveness by executing latest technologies before rivals and it adopts multiple approaches to outcompete other (Ameer & Khan, 2020). To calculate competitive aggressiveness in software firms we borrow measures from (Alshanty & Emeagwali, 2019).

Autonomy

EO autonomy is the firm working independently, making decisions, taking actions, assigning individual delegation, and supporting empowerment (Krauss et al., 2005; Rauch et al., 2009). Autonomy offers firm workforces individual liberties (and often liberty within teams) to enhance personal creativity and vision, and to promote favorable environments for entrepreneurship to occur (Omisakin & Adegoke, 2022). Autonomy supports innovation and creativity, and these link towards quality performance. Autonomy enables individual freedom, but brings enforced controls to prevent misuse (Wales et al., 2013). Autonomy encourages firm entrepreneurship, but also promotes opportunistic individualistic behavior (Lumpkin & Dess, 1996). Autonomy contributes to new ideas, but remains hard to estimate, especially as to its linked contributions towards marketplace acceptance (Tresna & Raharja, 2019). Autonomy positively links towards entrepreneurial firm performance (Gauthier et al., 2021). Management helps build innovation and creativity to emergent opportunities and problems in entrepreneurial firms (De Jong & Den Hartog, 2007, Ireland & Webb, 2007). Managers can also facilitate firm-wide autonomy and balance smart resourcefulness against rule-breaking, along with firm and individual initiatives (Peters & Kallmuenzer, 2018), especially when pursuing novel opportunities (Baier-Fuentes et al., 2019).

Innovative firm structures with smooth hierarchies of authority, may offer powers of decision-making to operate as an independent entity or autonomously. These can promote ongoing business innovation and new ventures (Arshi et al., 2020). Thus, innovation and autonomy likely covary. Further, autonomy links towards ACs and supports their active implementation of change. Thus autonomy relates to ACs across its constructs, and this forms the hypothesis block of H6a-d. Further, autonomy combined with innovation link to the ongoing enhancement of a SM and to a SCA for the firm. This is hypothesized as H16.

- H6a: Autonomy positively influences acquisition
- H6b: Autonomy positively influences assimilation
- H6c: Autonomy positively influences transformation
- H6d: Autonomy positively influences exploitation
- H16: Autonomy positively influences SCA

Autonomy is important in building firm performance in software firms. By providing ability to work independently to other employees, creating small departments according to tasks, giving employee freedom to individually solve queries and develop a product part, novel ideas emerge that can further empower SCA in the marketplace (Hakala, 2013). To study autonomy in software firm we adapted measures from (Alshanty & Emeagwali, 2019).

Risk-Taking

Risk-taking is firm tendency to take uncertain initiatives and execute risky activities whose results are not sure (Peters & Kallmuenzer, 2018). EO, early researchers described risk taking as firm risk due to new entry and innovation (Miller & Friesen, 1982). Today risk taking is a firm skill dependent upon entrepreneurial desires for control/development/operation of risky ventures (Corrêa et al., 2022). SMEs - like software firms, see entrepreneurial risk-taking as linking with capabilities performance levels (Meekawekunchorn et al., 2021), with risk assessed against fiscal impact of firm capabilities performance levels (Belás et al., 2018). Risk taking can be structural and/or organizational, and set against firm goals and objectives (Brettel et al., 2015).

Risk taking can be high if firms acquire (1) large/risky investments, (2) new venturing resources, (3) new human and financial resources for untested marketplaces, (4) large bank debts (Baker & Sinkula, 2009, Filser & Eggers, 2014). Risk is not gambling. It is a summary calculation, and often includes safety hazards (Dess & Lumpkin, 2005). Risk averse firms often miss advantageous opportunities, and so create missed opportunities risk (Nishimura, 2015). Risk can be external and internal and miscalculated leaving the firm further and less competitive (Bekefi et al., 2008). Hence there remains a wide gap in EO literature concerning the risk taking construct and its measurement dimensions (Naldi et al., 2007).

Risk taking relates to ACs constructs, and this forms the hypothesis block of H3a-d. Also, risk taking is a competency measure, and it likely covaries with innovative strategies, levels of autonomy, degrees of proactiveness, competitive aggressiveness, and

to some degree KC. Further risk taking likely impinges on ongoing enhancements to a SM and to a SCA. This is hypothesized as H13.

- H3a: Risk taking positively influence acquisition
- H3b: Risk taking positively influence assimilation
- H3c: Risk taking positively influence transformation
- H3d: Risk taking positively influence exploitation
- H13: Risk taking positively influence SCA

Risk taking in software firms is a common occurrence as they develop new projects to consumer requirements. By analyzing their past projects, designing prototypes, and apply beta testing, firms take calculated risks against new technologies and platforms. To study risk taking in software firm we borrow measures from (Alshanty & Emeagwali, 2019).

Entrepreneurial Orientation and Sustainable Competitive Advantage Relationship

The resource-based view believes a firm's higher performance and SCA arise from firm-specific capabilities and resources that are not as affordable to competitors, and/or are rare, and/or are values laden, and and/or non-substitutable (Mullens, 2018). Resources contain, but are not restricted to, capabilities, assets, organizational processes, information, firm attributes, and knowledge (Barney, 1991). EO refers to existing procedures or competencies, and these may then lead towards creating a new capabilities opening, and this intangible resource can be used by the firm to help create SCA (Ibarra-Cisneros & Hernandez-Perlines, 2020). Intangible assets, rather than physical ones, often drive different firms' performance levels - because intangible firm assets are normally not as vulnerable to imitation by competitors as are physical firm assets (Mostafiz et al., 2021).

Considering software firms, EO is processes, practices, philosophy, and decision-making activities helping then innovate (Emami et al., 2022). Firms with solid EO management continuously seek new opportunities towards strengthening their sustainable competitive positions (Hidayat et al., 2021). Opportunities are not necessarily associated with something new, and they can be related to optimizing current firm structures (Covin & Wales, 2019). Firms committed to pursuing SCA, likely review the dynamics of their marketplace and their entrepreneurial advantage (Jansson et al., 2017). Thus software firms continue to work on new capabilities pathways to overcome obstacles and to retain their SCA. EO can help the firm frame capabilities opportunities and also adapt to technological and other changes (Arshi et al., 2020). Hence this study hypothesizes that for software firms, there is a likely positive transition from EO to ACs and to SCA,

Absorptive Capability

AC is the firm's ability to recognize, assimilate, transform and utilize resources from the environment. These auctioning dimensions suggest that is not only the ability to reproduce already present technological solutions and products, but it also enables the firm to develop new products/services by combining new and existing knowledge (Zahra & George, 2002). AC facilitates firms to be responsive to valuable external knowledge to recognize opportunities according to current vibrant needs and a dynamic business environment (Lee et al., 2018). AC allows firms to constantly reconfigure their existing capabilities and resources stocks, and to action and create new helpful capabilities and knowledge components to meet environmental and business needs (Wang et al., 2020). According to dynamic customer requirements, firms – like software firms, can then adaptively and flexibly utilize their new and developing resources to feedback, modify, and re-create superior competencies, and/or product/service capabilities into more efficient and technological beneficial developments (Migdadi, 2022). Thus, AC is not about updating firms, but it is about innovating, and generating new knowledge and resources (Lichtenthaler, 2016). Hence, it is likely important for firms to invest in AC, since this can, enhance, complement and refocus its knowledge base (Flor et al., 2018).

AC divides into two groups: potential AC and realized AC (Zahra & George, 2002) - with four further primary capabilities constructs or dimensions (1) acquisition of new beneficial knowledge, (2) assimilation of acquired knowledge, (3) transformation of refined, integrated knowledge, (4) exploitation by altering knowledge into firm operations (Usman et al., 2022).

Acquisition and assimilation are potential ACs and transformation, and exploitation are realized ACs (Ahmed et al., 2020). Each dimension is believed a distinct capability of a firm, and collectively they deliver AC (Sun & Anderson, 2010), and further explain dynamic influences of knowledge mechanisms against marketplace change conditions (Zahra & Hayton, 2008).

Acquisition

Acquisition is a firm (or a software firm) ability to identify/gather/apply external resources and increase performance. This is knowledge focused (Zahra et al., 2009) towards firm resources and R&D actions. Intangible acquisition influences include determination to acquire knowledge, speed, intensity, motivation and the selected direction (Rodríguez-Serrano & Martín-Armario, 2019), plus inter-functional exchange interfaces and staff participation (Lichtenthaler, 2016). Resultant technology updates focus towards out-competing market rivals (Lee et al., 2018). We adapted measures from (Jansen et al., 2005), (Engelman et al., 2017), (Flatten et al., 2011) and (Lee et al., 2018)

Assimilation

Assimilation is routines and processes that let firms examine/process/explain/appreciate information gained from external sources (Zahra & George, 2002). These helps mobilize capabilities actions such as thrive to learn new things or training about new market trends (Hernández-Perlines et al., 2017). Knowledge assimilation measures according to firm managerial task, compensatory, centralization functions (Flor et al., 2018). Assimilation also develops across exchange or inter-firm interfaces, and good connectivities pathways (Knoppen et al., 2011).

Assimilation from the software firm perspective enlists processes to identify/capture requirements fitting the construct's capabilities. External information and technologies coalesce into relevant innovative strategic actions (Lee et al., 2018). We adapted measures from (Jansen et al., 2005), (Engelman et al., 2017), (Flatten et al., 2011) and (Lee et al., 2018).

Transformation

Transformation refers to a firm capability to refine/develop/action routines which assist in the combination of prior/newly acquired resources (Zahra & George, 2002). Transformation offers two elements - internalization and conversion. These measure as impact of research projects against new product and/or innovative ideas (Volberda et al., 2010). This area lacks detailed empirical and theoretical dimension support. Recent conceptual literature suggests transformation is affected by entrepreneurial factors (1) coordination skills, (2) systems facilities, (3) socialization workforce abilities.

Software firms apply new software versions/policies to frame compatibilities against developed products and external marketplace environments They also create new algorithms with gained knowledge and store these for future use in different products/services. We adapted measures from Jansen et al., (2005), Engelman et al., (2017), Flatten et al., (2011) and Lee et al., (2018).

Exploitation

Exploitation is firm ability to use new external resourcing and increase innovation to increase firm performances (Lichtenthaler, 2016). Exploitable capability either enhances/expands/influences existing capabilities or creates/actions new knowledge capabilities (Usman et al., 2022). The capability to exploit knowledge is affected by accessibility of connectivities mechanisms, formalization mechanisms, and socialization tactics (Zahra & Hayton, 2008). The qualitative research of five biotechnology firms explored ACAP process, concluding several vital characteristics exist across ACs process. It also confirms cumulative/multidimensional/interactive features of procedures highlight the iterative, uncertain, and nonlinear nature of ACs process.

Exploitation in software firms set multi-probe rules against delivering monetary and strategic benefits, which include significant development of prototypes, assigning tasks to different departments, confirming use of programming software and implementation of other specified technologies by means of active knowledge transfer. We adapted measures from Jansen et al., (2005), Engelman et al., (2017), Flatten et al., (2011) and Lee et al., (2018).

Absorptive capability: Mediation between Knowledge Creation and Sustainable Competitive Advantage

Past era knowledge sources often deployed KC including (1) importing capital goods, (2) education and (3) technology licensing (Sahasranamam et al., 2019). Today, firm knowledge-based resources direct towards technological knowledge, and software (Ismail et al., 2018), and economic firm-related competencies and capabilities link with SCA (Wang et al., 2020). Some studies links KC and ACs relationship pathways (Knoppen et al., 2011; Scuotto et al., 2017; Volberda et al., 2010; Zahra & George, 2002), and a skilled workforce also helps build firm ACs (Ahmed et al., 2020). Firm EO competencies also help create marketplace opportunities. These articulate into initiated absorptive capacities that raise performance channels towards generating SCA (Scuotto et al., 2017). Researchers (1) explore AC as improving EO (Zahra et al. 2009), or (2) adopt AC as moderating EO-to-firm performance-related outcomes (Zahra & Hayton 2008). Engelen et al., (2014) use AC as moderator in estimating EO on performance-related outcomes such as SCA.

In this study, AC is proposed as mediating between EO and SCA, with links between new information/ knowledge pathways pursuing ongoing/potential marketplace opportunities (Hernández-Perlines et al., 2017). Additionally, a strong EO and high AC improves innovation activities and speed, helps develop new products and services in respond to marketplace opportunities and likely positions the firm with a stronger SCA (Zhai et al., 2018). Hence based on the above sections of research, this study recognizes the EO and SCA relationship can be expanded by including the likely mediating effect of AC. This relationship also supports the embedded hypotheses H7 H8 H9 and H10.

- H7: ACs have positive influences on firm SCA
- H8: ACs have positive influences on firm SCA
- H9: ACs have positive influences on firm SCA
- H10: ACs have positive influences on firm SCA

Sustainable Competitive Advantage

Sustainable Competitive is measured by an organizational success that uses internal resources to satisfy consumers in the marketplace and by meeting consumer demands more than their competitors (Maury, 2018). In competitive and slow-growth markets, firm leaders focus on achieving SCA (Hossain et al., 2021). A firm can have competitive edge after implementing a

strategy capable of producing profit or unique benefit. A firm has SCA when other companies cannot replicate the same strategic value (Barney et al., 2001).

Competitive advantage is described through exogenous or market factors and internal resourcing (Liu & Mantecon, 2017). A firm’s high performance outcomes emanate via (1) traditional industrial organization economics considering competition and industry influences and ongoing above-normal returns (Porter, 1985, Li et al., 2021; Nguyen Dang Hoang et al., 2021). Economic performance captures social allocative efficiency, customer satisfaction, and strong profitability (Hossain et al., 2021). Alternatively a firm’s high performance outcomes emanate via (2) unique blends of resources and capabilities that coalesce and enhance performance (Barney, 1991). In addition to resource-based theory, firms seek costly-to-copy inputs, and where possible, also seeks improvements/opportunities for further capabilities actioning that can shift firms towards pursuing a SCA, and likely expanding their marketplace (Anning-Dorson, 2018). Thus, value of firm-actioned capabilities to continuously pursue further marketplace returns against rivals can help drive a SCA (O'Malley & O'Gorman, 2001, Torres et al., 2018).

Firms identify (1) product/presentation tactics, (2) develop core capabilities, (3) employ skilled workers, and (4) collect intellectual assets (Hult et al. 2001, Dimitrieska, 2016). They improve these constructs, generate greater economic worth (Ferreira et al., 2021) and coalesce them into a SCA (Sigalas & Papadakis, 2018). SCA relies on four constructs (1) profitability, (2) sustainability, (3) firm reputation to perform and deliver, and (4) good governance (Aras & Crowther, 2010). Software firms evaluate aspects that holistically constitute a SCA (Knudsen et al., 2021; Orr, 2019). They consider the firm as a whole, and view how each construct is addressed (O'Malley & O'Gorman, 2001). However, every construct is likely essential to business success, and when combined, can likely lead towards enhanced outcomes in terms of SCA (Aras & Crowther, 2010). Hence this study considers SCA, as a likely culmination of conjoint coalesced, and maybe networked construct approaches.

Within firms - like software firms, SCA is captured as competencies and capabilities, consumer perception, quality of servicing, firm governance, financial profitability, Innovation, Marketplace indicators, firm strategies, product features, sustainability, and resourcing attributes (Aldar, 2018, Torres et al., 2018, Uraon & Gupta, 2019, Severo et al., 2020, Sharma & Sharma, 2020, Hossain et al., 2021, Bhandari et al., 2022, Shah, 2022). These constructs help elevate investment profits (Liu & Mantecon, 2017), hinder rivals from nullifying firm performance outcomes (Arsawan et al., 2020), present new opportunities and new knowledge that offers sustained firm elevation within marketplaces (Karia & Asaari, 2016) and keeps it ahead of competitors in the industry (Rua et al., 2018). To measure firm performance as SCA, this study borrows four constructs and items from Aras and Crowther, (2010), Lee et al., (2018) and Mahdi et al., (2019).

RESEARCH PURPOSE

As EO supports ACs and ACs mediates EO and SCA, this study establishes its software firm research framework for sustainable competitive advantage in Pakistan, and presents as Figure 1. The research framework model also accounts for the hypotheses developed and included across the above materials.

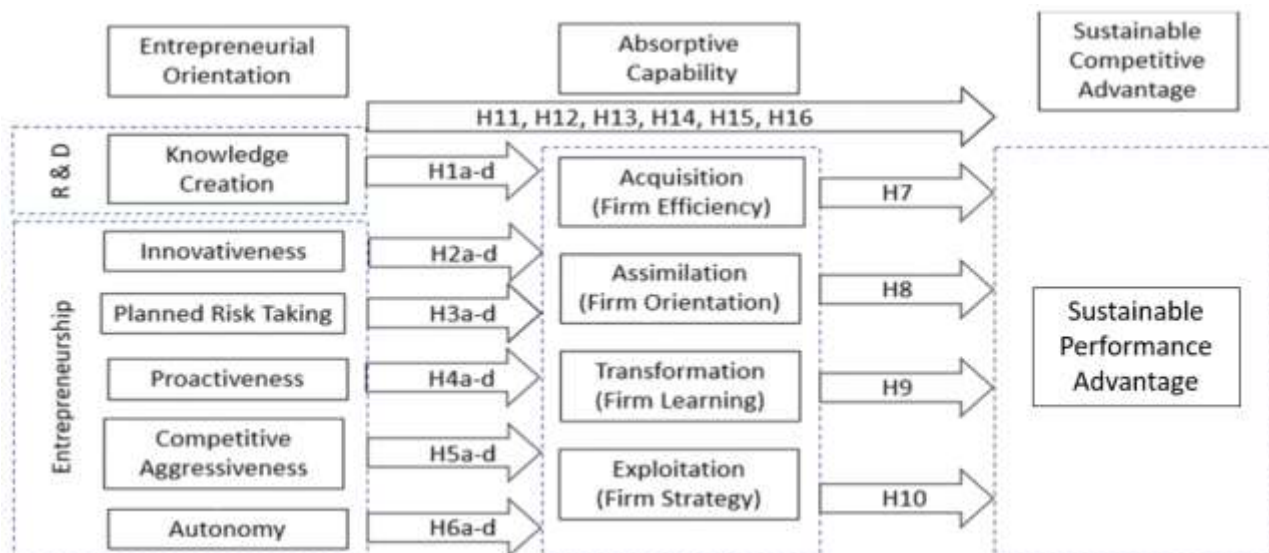


Figure 1. Research Framework for Software Firms pursuing SCA.

METHODOLOGY, PROPOSED ANALYSIS PLAN AND ACKNOWLEDGMENT

Both James Cook University’s College of Business, Law and Governance (through this doctoral study) and The Ministry of Information Technology & Telecommunication Pakistan Software Export Board (from 07/12/2021) (through its surveying assistance and member support) are supporting this study’s data capture across Pakistan’s six key digital software development cities. Software firm registered-members in Pakistan are emailed the survey link, six times (at regular intervals) across 6 weeks (to maximize response rates). They are also email advised of the industry value regarding completing this study’s digital

survey. Video-clip emails are included in both the fifth and sixth email (to further encourage laggard responders). A Likert 5 point (1= strongly disagree to 5 = strongly agree) survey is supported by qualitative open ended questions and demographics. Data analysis across 250 plus respondents from 3775 members offers suitable for AMOS28 SEM or Mplus quantitative path analysis modelling and construct total effects assessment, provided discrimination, model significance ($p > 0.05$), calibration and validation requirements are achievable. This mixed methods study approach also involves qualitative analysis. First open ended question text responses are coded into relevant themes. NVivo is engaged for theme analysis of these unstructured responses. Theme analysis approaches followed include word cloud/tree, directional project mapping and 3D cluster analysis.

RESULTS AND DISCUSSION

A mixed methods study is beneficial in this study. SEM or Mplus 'standardized total effects' provide a relative importance measure of constructs and their items. This is useful when prioritizing maximum effect adjustments to constructs. NVivo word cloud/tree analysis provided linkages to terms and the relative degree of their importance. The directional project mapping provides support for SEM modelling pathways. 3D cluster analysis provides special relations between constructs and items. These approaches are likely useful when modelling for item improvements across EO constructs, and ACs constructs, and when deployed collectively to drive SCA shifts. NVivo theme/mapping findings further triangulate study precision against literature and SEM. These findings likely offer feedback pathways to prioritize, and then improve, specific constructs and/or items offering most benefit to software firms in Pakistan as they pursue enhanced sustainable competitive advantage positioning.

EXPECTED CONTRIBUTION AND CONCLUSION

SCA in entrepreneurial software firms in Pakistan can likely be assisted using the research framework displayed in Figure 1. This involves acquiring better understanding regarding the relationships and total effects of six inputs constructs through to four intermediary constructs, and then into four output constructs, and using this understanding to refine and optimize the system in order to deliver SCA for a software firm. The approaches suggested above are likely applicable to software firm and software industries operating in highly competitive environments beyond Pakistan. This area of research is now available to researchers.

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The effect of pandemic and website information on consumers' perceived satisfaction in the hotel industry: An exploratory study focusing on e-marketplace consumers in South Korea

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ABSTRACT

The emergence of the e-marketplace and the Pandemic have had both large and small effects, especially on the tourism and hotel sector. Although several studies have analyzed consumer satisfaction, the impact of the Pandemic on consumers' satisfaction in the e-marketplace environment has received much less attention. Therefore, this study aims to investigate consumers' perceived satisfaction with their accommodation during the COVID-19 outbreak by analyzing website information provided by consumers and hotels. This study examines star rating as a moderating effect on consumers' perceived satisfaction and the impact of the Pandemic. This study collected data from the Coupang travel platform, one of Korea's largest e-marketplaces, and 1,018 responses were used. Based on the OLS regression approach, the results state that consumers' perceived satisfaction differs before and during COVID-19. In addition, there is a moderating effect of star rating, and perceived satisfaction tends to decrease as the star rating increase. Furthermore, the volume of reviews and hashtags that consumers and hotels provide positively affect perceived satisfaction. This study provides new insights into the e-marketplace approach, considering website information in the tourism literature from an e-business perspective.

Keywords: e-marketplace, perceived satisfaction, website information, hotel industry, Pandemic.

INTRODUCTION

The Internet has had a vast and pervasive impact on many industries, one of which is emerging online marketplaces. An online marketplace or e-marketplace is a fast-growing digital store; virtual stores outperform offline stores, where offline stores have turned into online stores (Christian, Chandra, 2021). In today's technology, e-marketplace has taken over stores worldwide and made all offline stores online. Nevertheless, because of the large number of consumers who go from offline shopping to online, the purchased products are not necessarily following the consumer's wish, so the consumer sends feedback or reviews to the e-marketplace (Book et al., 2018). Consumer reviews or feedback significantly impact e-marketplaces because consumers who use the e-marketplace can see and assess whether it can be trusted. So that other consumers also believe in the feedback from other consumers (Castelli et al., 2017).

E-marketplace in hospitality and tourism has progressed in recent years from the prior sales of less-complex products such as accommodations, airline tickets, and car rentals to embracing more complex products, including vacation packages and cruises (Beldona, 2005; Inversini & Masiero, 2014; Nusair & Parsa, 2011). Specialized travel platforms such as Booking.com or TripAdvisor have also raised and received much attention from travelers. With the rapid development and popularization of e-commerce technology, more and more users like to shop on various e-commerce platforms (Yang et al., 2020). However, as the products on e-commerce platforms are full of varieties and styles, consumers started to choose platforms and products based on their subjective factors.

From the perspective of hotel products in the generalized e-marketplace, hotel companies secure many consumers within a short period without marketing expenses or considerable efforts to overcome NO-SHOW and low season (Song et al., 2018). In this regard, the generalized e-marketplace is an optimal environment for consumers to purchase hotel products by utilizing deals that offer discounts on various hotel products and building a channel to talk with others by considering previous consumers' ratings and reviews. However, previous studies are limited to only studying purchase intention and satisfaction for overall products of social commerce (Lee & Lee, 2016; Han et al., 2012) or specialized travel platforms. Therefore, research on the hotel perspective in the generalized e-marketplace is insufficient.

Furthermore, COVID-19 has impacted almost every aspect of the hotel business (Gossling et al., 2020). Owing to the unique features of the Pandemic, such as its long duration, large externalities, and broad impacts, COVID-19 has affected the decision-making of consumers more significantly than other crises of the same nature (Song et al., 2022). Although there have been several studies on the analysis of consumer satisfaction, the impact of COVID-19 on consumers' satisfaction has barely started to investigate. It is essential to examine dimensions of satisfaction from online consumers' reviews to recognize their evaluations of the hotels' services during COVID-19.

Considering the external factors that consumers will be affected by in the e-marketplace environment, this study aims to reveal consumers' perceived satisfaction with their accommodation during the COVID-19 outbreak by analyzing website information provided by consumers and hotels. In addition, this study investigates whether star rating has a moderating effect on consumers' perceived satisfaction. While previous studies focused on analyzing consumers' satisfaction with specialized travel platforms, this study tries to fill a research gap by collecting data from a generalized e-marketplace platform and exploring to be generalized to other contexts in a big e-commerce concept. Furthermore, other studies have mainly concentrated on investigating only consumer-based content, such as online reviews and standardized ratings posted on online platforms, as the primary forms of User-Generated-Content (UGC). This study shed some light on considering both contents provided by consumers and hotels.

Based on the above discussion, this study attempts to answer two research questions: (1) How do e-marketplace consumers perceive satisfaction with hotel products before and during COVID-19 considering the moderating effect of star rating? (2) What kind of hotel website information affects consumers' perceived satisfaction? To address these questions, this paper is organized as follows: the literature review explains the motivations of the study by reviewing related literature; the methodology introduces a conceptual model, data acquisition and collection, measurement, and data analysis; the result provides the regression analysis results considering both main and moderating effects. Moreover, in the end, the discussion and conclusion are successively presented, including theoretical, managerial implications, and limitations.

LITERATURE REVIEW

Discrepancy Theory

Discrepancy theory research studies the difference between an a priori state and subsequent perception (Jiang et al., 2012). A discrepancy is a perceived difference between an anchor and a personal understanding of accomplishment along the same dimension. The anchor can be set by social pressure, established employment goals, personal expectations, threshold requirements, free markets, or any agency or existing bias (Michalos, 1985). Depending on the theory, the perceived discrepancy can result in several effects, including an adjustment or dismissal of the anchor, a change in the perception of accomplishment, or a resulting belief that may lead to a particular attitude or action. The magnitude and direction of the discrepancy assist in determining the level of satisfaction.

According to the discrepancy theory, an individual is more likely to feel a sense of happiness when they judge that they are superior to others (the target of comparison). Applying this to our study, we expect that, in a difficult situation due to COVID-19, the act of rejuvenating people by leaving their homes and visiting external tourism elements can provide people with a sense of happiness compared with those who are normally staying. Therefore, regardless of the external tourism factor (hotel) condition, it can be predicted that visiting a hotel in a difficult situation caused by COVID-19 will increase people's subjective satisfaction more during COVID-19 than before COVID-19.

Consumer Satisfaction and Hotel Attributes during Pandemic

Consumer satisfaction and dissatisfaction have been an essential topics in the hospitality sector. In this sector, service quality or satisfaction is critical (Rauch et al., 2015), and it is the gap between perceived and expected service quality (Padma & Ahn, 2020). Traditionally, service quality was assessed by different attributes, such as location, room service, cleanliness, comfort, the attitude of staff, booking process, and complaint handling. Song et al. (2022) found that hotel consumer satisfaction and its influencing factors have changed significantly during the Pandemic; hotel consumer satisfaction during the Pandemic is mainly influenced by service quality. In a similar context, Nilashi et al. (2021) stated that the service quality during the outbreak is essential for consumers and has impacted their satisfaction levels during the COVID-19 outbreak. Through sentiment analysis, Mehta et al. (2021) found a significant drop in the satisfaction level during April, May, or June when perhaps fear due to the COVID-19 Pandemic was at its peak. The analysis revealed that staff, overall service, cleanliness, room, booking experience, and time are the primary sources of dissatisfaction. Considering the moderating role of crisis response strategy, Yu et al. (2020) stated how the hotel industry has adopted strategies to shape consumers' experience and satisfaction. They suggested that 'rebuild strategies' dominated most hotels' response to the COVID-19 crisis, while the quantitative findings confirm the direct impact of affective evaluation and cognitive effort on consumer satisfaction.

Equity Theory

The Equity theory captures the concept of fairness perception, which has been used to explain how consumers respond to recovery efforts (e.g., Alexander, 2002; Sabharwal et al., 2010). In other words, equity incorporates a concept of a continuum ranging from the transaction-specific state (the state when a relationship has been started) to the state when the relationship has been accumulated over a long period. Hence, we assert that equity theory provides an understanding of consumers' subjective perception of their outputs and inputs. Specifically, consumers will feel fairness depending on how they perceive the gain

(output) compared to what they put (inputs) for their hotel stay. The input level would differ depending on the star rating, the possibility of reasonably matching the input and output levels will decrease. Therefore, through this theory, we assert that consumers who reserve the higher the star rating accommodation, the higher the probability of feeling unfairness of experienced output from consumers.

Country and Platform based Consumers Satisfaction

Consumers from different cultures have different services and amenity expectations; therefore, their overall positive and negative sentiments will vary with the same type and level of services. In this regard, Peres and Paladini (2022) focused on identifying the main negative topics related to the quality of hotel services in Brazil and the impacts of the COVID-19 Pandemic on guests' perceptions of these topics from the TripAdvisor database. They identified 13 topics related to five attributes of hotel service quality. Specifically, the topics related to room cleaning and check-in were the most negatively impacted by the COVID-19 Pandemic, with the largest drops in average evaluation scores. From the Taiwan perspective, Lin and Chen (2022) examined international tourist hotels with high product varieties from the government's database. Five-star hotels suffered a greater loss in revenue than other types of hotels, while hotels located in scenic areas and international chain hotels were less affected. Nilashi et al. (2021) revealed travelers' satisfaction in Malaysian hotels during the COVID-19 outbreak from the TripAdvisor source. They provided evidence that the impact of the quality of services during COVID-19 on the relationship between service and satisfaction is high.

South Korea (hereafter, Korea) is where the e-marketplace environment is very well developed, and consumer involvement in the EWOM (electronic word of mouth) system is prevalent. The Korean e-marketplace environment is worth considering for general e-marketplace shoppers in the hotel sector. Plus, e-marketplaces in Korea provide a well-built EWOM system (Yoo et al., 2015). Based on the above discussion, this study focused on the Korean environment as an appropriate environment for this study and an adequate representation of the e-marketplace. Table 1 presents the relevant literature summary that we mentioned as follows.

Table 1: Relevant literature summary

Studies	Main Theme	Platform	Geography	Major Findings
Yu Song et al. (2021)	This study explores the difference between the influencing factors of consumer satisfaction before and during the COVID-19 outbreak.	CTrip	Chengdu (China)	Hotel consumer satisfaction and its influencing factors have changed significantly during the Pandemic; hotel consumer satisfaction is mainly influenced by service quality.
Mihir P. Mehta, Gopal Kumar & M. Ramkumar (2022)	This study aims to assess consumer satisfaction by conducting sentiment analysis of continents from January to September 2020, i.e., during the COVID-19 Pandemic.	TripAdvisor	USA, UK, India, Indonesia, Malaysia, Singapore, Sri Lanka	There was a significant drop in the satisfaction level during April, May, or June when perhaps fear due to the COVID-19 Pandemic was at its peak. The analysis revealed that staff, overall service, cleanliness, room, booking experience, and time are the main sources of dissatisfaction.
Meng Yu et al. (2022)	This study examines how the hotel industry has adopted strategies to shape consumers' experience and satisfaction.	TripAdvisor	-	'Rebuild strategies' dominated most hotels' response to the COVID-19 crisis, while the quantitative findings confirm the direct impact of affective evaluation and cognitive effort on consumer satisfaction.
Clerito Kaveski Peres and Edson Pacheco Paladini (2022)	This study is dedicated to identifying the main negative topics related to the quality of hotel services in Brazil and the impacts of the COVID-19 Pandemic on guests' perception of these topics.	Booking.com	(Respondent) Brazilian	A total of 13 topics ¹ related to five attributes of hotel service quality were identified. The topics related to room cleaning and check-in were the most negatively impacted by the COVID-19 Pandemic, with the largest drops in average evaluation scores.

¹ Bathroom in the room, room facilities, noise, room cleaning, bed, internet-TV, parking lot, infrastructure, check-in, reservation, staff, restaurant, and breakfast

Mehrbakhsh Nilashi et al. (2022)	This study aims to present a new method combining machine learning and survey-based approaches for consumer satisfaction analysis during the COVID-19 outbreak.	TripAdvisor	-	The influence of service quality during COVID-19 on hotel performance and consumers' satisfaction was elaborated. The textual reviews show that the service quality during the outbreak is important for the consumers and has impacted their satisfaction level during the COVID-19 outbreak.
Yu-Chen Lin & Chiang-Ming Chen (2022)	This study examines whether different hotel characteristics moderate the impact of the COVID-19 Pandemic on hotel performance.	International Tourist Hotels	Taiwan	International tourist hotels with high product varieties and five-star hotels suffered a greater loss in revenue than other types of hotels. In contrast, hotels located in scenic areas and international chain hotels were less affected.
Mehrbakhsh Nilashi et al. (2021)	This study aims to reveal travelers' satisfaction with Malaysian hotels during the COVID-19 outbreak through online consumers' reviews.	TripAdvisor	Malaysia	The results show high impact of service quality during COVID-19 on the relationship between service and satisfaction.

The previous studies reported a significant difference in hotel consumer satisfaction before and during COVID-19. In particular, by analyzing online reviews and ratings before and during COVID-19, consumers' overall satisfaction was significantly higher during the COVID-19 outbreak. As a cause of this, some studies pointed out that consumers' standards for hotel performance criteria are changing due to various external factors of COVID-19. However, the apparent lack of research raises the question of whether consumers who purchase hotel products on e-marketplaces other than specific travel platforms such as TripAdvisor show the same satisfaction pattern. In particular, it is necessary to examine what external information is recognized by consumers who purchase accommodations from different countries on platforms commonly used in that specific country and whether this significantly affects their perception of satisfaction later.

METHODOLOGY

Conceptual Model

In this paper, we present a conceptual model depicting the effect of the Pandemic and website information on perceived satisfaction. Star rating is also considered a moderating effect between the impact of the Pandemic and perceived satisfaction. We divide informants into consumers and hotels from the website information. The information provided by consumers includes online reviews written by previous consumers. The information provided by hotels has the photo volume and hashtag volume uploaded to the platform. The region and COVID-19 severity were also set as control variables to reduce the location effect of the tourist attraction. The conceptual model is presented in Figure 1.

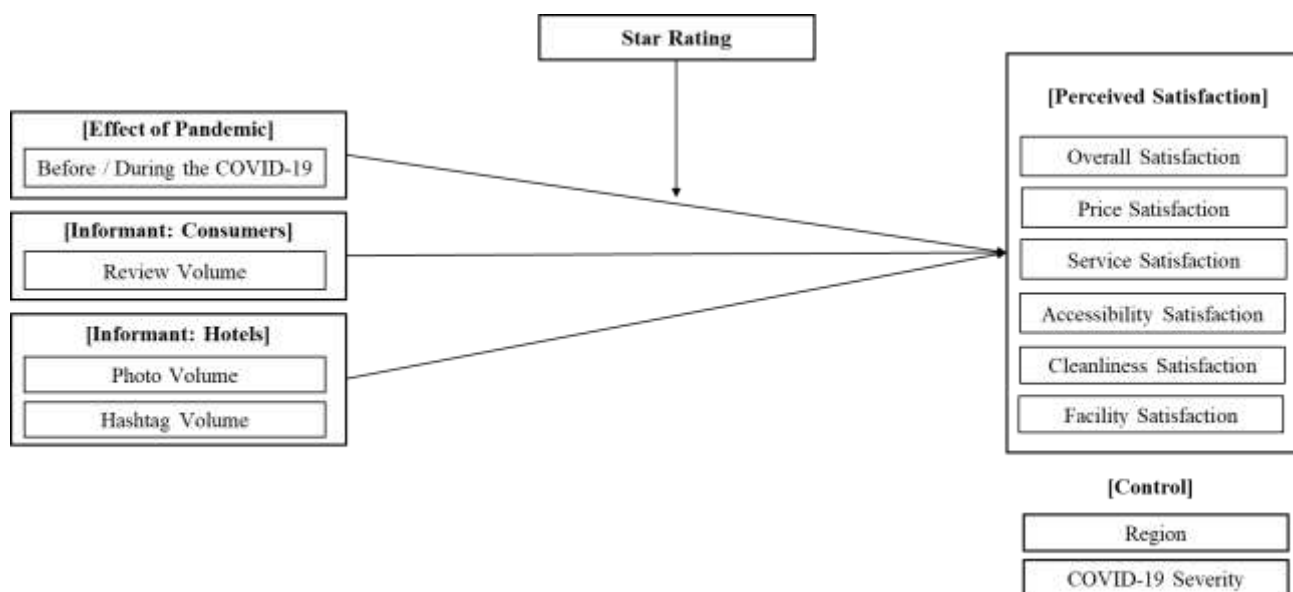


Figure 1: Conceptual model

Data Acquisition and Collection

Website information was collected from the Coupang travel platform, one of Korea's largest e-marketplaces. As the purpose of our study is to investigate satisfaction patterns in hotel products in the e-marketplace, Coupang is appropriate for the aim of this study. The data from Coupang has been used in prior studies. Kim et al. (2015) investigated the impact of motivations on consumer satisfaction in the mobile tourism shopping context. They reported that many respondents (29.1%) named Coupang their favorite site over any other single site. Furthermore, Kim (2013) stated that given the rapid growth of social commerce sites such as Coupang, it has become important to explore consumer purchasing behavior in a social commerce environment.

Coupang travel is a specialized category for Coupang's travel products, providing a variety of tourism products. In this regard, Coupang travel suggests various hotel products, including hotel reservation services. Through this service, potential consumers can use this platform as a free search tool to scan hotel information and reserve the hotels with additional benefits that Coupang provides. One advantage of this platform is that it implements single and multi-rating systems, allowing consumers to choose which method they want to adopt actively. Both reviews and ratings provided by consumers can be checked in real-time. The platform only allows reviews to be sent to people who have paid for the reservation. For this study, responses of consumers who responded with the multi-rating system were only extracted. Data collection on the Coupang travel took place in an automated way. For this purpose, a crawler was developed and implemented in the Python programming language. All responses of multi-rating systems in the Coupang travel platform were extracted; therefore, the start date varies according to each hotel, and the end date was August 4, 2022.

Measurement

To address our research question, we used a novel proprietary dataset from Coupang travel comprising highly detailed information on hotel products. We collected cross-sectional information on hotel products and the ratings from the multi-rating system. Based on these steps, our dataset contained a total of 1,018 responses which consisted of 509 hotel products * two situations (whether it is under Pandemic condition or not).

In line with previous literature, this study defined January 2022 as the start of the Pandemic since the media was already reporting hundreds of COVID-19 cases in several countries, and the news was already causing great concern in the hospitality industry (Peres, Paladini, 2022). In the case of Korea, the Korean government established a COVID-19 monitoring and response system on January 3. Thus, we defined a dummy variable, COVID-19, assigned the value of 1 during COVID-19 (2020 ~) and 0 before COVID-19 (~2020).

Considering that the importance given by consumers to quality attributes may vary according to social and environmental factors in each context, the set of attributes from Coupang travel is used to evaluate consumers' perceived satisfaction. For each hotel product, we collected information about review volume from consumers with experience staying at the hotel, photo volume, and hashtag volumes each hotel offers. The key outcome variables for this study are each specific rating from the multi-rating system. Detailed ratings (or satisfaction type) are overall satisfaction, price satisfaction, service satisfaction, accessibility satisfaction, cleanliness, and facility satisfaction.

In addition, we collected several characteristics that can measure the severity of the Pandemic: the number of confirmed cases, fatalities, fatality rate, and region. Specifically, in this study, the number of confirmed cases indicates a cumulative confirmed case during COVID-19. The number of fatalities indicates a cumulative fatality during COVID-19. The fatality rate provides the ratio of fatalities to confirmed cases in each region. The region shows the area where a hotel is located. We used these variables as control variables and collected data from KDCA (Korea Centers for Disease Control and Prevention) database. The KDCA has been updating detailed adverse events data daily in Korea (Kim et al., 2021).

Table 2 shows a detailed description of the variables used in this study. Table 3 shows descriptive statistics for continuous variables.

Table 2: Description of study variables

Variables	Description
Key explanatory variables	
COVID-19	Whether it is under COVID-19 situation (2020 ~ = 1, ~ 2020 = 0)
Star	A rating of 1 to 5 according to hotel quality
<i>[Informant: Hotels]</i>	
Photo volume	How many photos were offered by hotels
Hashtag volume	How many hashtags were offered by hotels
<i>[Informant: Consumers]</i>	
Review volume	How many reviews were written by consumers
Dependent variables	
Overall satisfaction	An overall evaluation of the hotel

Price satisfaction	A specific evaluation of the consumer's price satisfaction relative to the hotel service
Service satisfaction	A specific evaluation of the consumer's service satisfaction from the hotel
Accessibility satisfaction	A specific evaluation of the hotel accessibility
Cleanliness satisfaction	A specific evaluation of the hotel cleanliness
Facility satisfaction	A specific evaluation of the hotel facility
Control variables	
Number of confirmed cases	A cumulative confirmed case of COVID-19
Number of fatalities	A cumulative fatality by COVID-19
The fatality rate	The ratio of fatalities to confirmed cases
Region	The area where a hotel is located

Table 3: Descriptive statistics for continuous variables

Variables	Obs.	Mean	Std. Dev.	Min	Max
Star	1,018	3.27	0.96	1	5
Review volume	1,018	52.49	131.29	1	1879
Photo volume	1,018	40.77	31.23	4	225
Hashtag	1,018	4.63	2.17	1	12
Overall satisfaction	1,018	2.69	2.09	0	5
Price satisfaction	1,018	2.69	2.08	0	5
Service satisfaction	1,018	2.72	2.11	0	5
Accessibility satisfaction	1,018	2.76	2.15	0	5
Cleanliness satisfaction	1,018	2.69	2.13	0	5
Facility satisfaction	1,018	2.6	2.09	0	5

Data Analysis

We made a regression approach to investigate the relationship between the Pandemic condition and each type of satisfaction with control variables. Specifically, we estimate the following ordinary least squares regression, including region-fixed effect with robust standard errors. We assume the following causal relationship between the impact of the Pandemic and perceived satisfaction:

$$Perceived\ Satisfaction_{i,j} = \beta_0 + \beta_1 Covid19 + Region_j + \gamma CV_{i,j} + \varepsilon_{ij} \tag{1}$$

In Eq. (1), the dependent variable is each perceived satisfaction from the multi-rating system against hotel product *i* with region *j*. *Perceived Satisfaction_{i,j}* consists of six satisfactions, which are overall, price, service, accessibility, cleanliness, and facility ratings. Overall satisfaction is our main dependent variable in this study, and it represents the average value of all other satisfactions when customers evaluate hotels in a multi-rating system. Additionally, we investigate each of the specific satisfactions which are for price, service, accessibility, cleanliness, and the facility as dependent variables to investigate how the overall satisfaction is driven by specific satisfactions as it is average value. We also investigate how the Pandemic situation affects each specific satisfaction. *Covid19* is the main explanatory variable representing the Pandemic situation. It indicates whether customer reviews are written before or during the COVID-19 situation. We included region *j* to control the location effect for the same brand hotels located in different regions. *CV_{i,j}* indicates control variables representing the other information from consumers and hotels. We also include variables which are the number of confirmed cases, the number of fatalities, and the fatality rate to control the severity of COVID-19 in each region in this model.

Next, we employ the star rating, which indicates a rating of 1 to 5 according to hotel quality, to measure the moderating effect. Each hotel has a rating evaluated for hotel quality and is displayed on the website information. We assume that star rating moderates the relationship between the Pandemic impact and perceived satisfaction. We put the variable “star” and “covid19 times star” as an interaction term in Eq. (1). The following equation indicates the moderating effect model:

$$Perceived\ Satisfaction_{i,j} = \beta_0 + \beta_1 Covid19 + \beta_2 Star_{i,j} + \beta_3 Covid19 * Star_{i,j} + Region_j + \gamma CV_{i,j} + \varepsilon_{ij} \tag{2}$$

We expect β_3 shows a significant relationship, which means hotels with higher star-level moderate the relationship between the COVID-19 and perceived satisfaction.

RESULTS

This section presents the results of the estimations. We present the ordinary least squares results (OLS) in Table 4. Based on Eq. (1), column (1) describes the model of each variable’s effect on overall satisfaction which is our main dependent variable with control variables and fixed effect. Columns (2) to (6) provide the results of how the Pandemic situation affects price satisfaction, service satisfaction, accessibility satisfaction, cleanliness satisfaction, and facility satisfaction respectively. The results in columns (1) to (6) consistently show that COVID-19, review volume, and hashtag volume are statistically significant.

Specifically, COVID-19 significantly and positively affected all satisfaction types, consistent with the previous literature. A potential explanation for this result is that when consumers evaluate the satisfaction of each factor for a hotel, they are aware of the COVID-19 situation and evaluate it in consideration of this condition. Looking into each column, the coefficients (β) of COVID-19 are 1.087 for overall satisfaction, 1.123 for price satisfaction, 1.079 for service satisfaction, 1.177 for accessibility satisfaction, 1.056 for cleanliness satisfaction, and 1.031 for facility satisfaction, at less than a 1% significance level. The results in columns (2) to (6) also show that all specific satisfactions are positively affected by the Pandemic situation. These results suggest that the increase in all specific satisfactions drives the increase in overall satisfaction. The coefficients show the effect on accessibility satisfaction as the largest in magnitude, while the coefficient of COVID-19 investigates the effect on facility satisfaction as the smallest in magnitude.

Moreover, review and hashtag volumes significantly and positively impacted all consumers’ perceived satisfaction. Regarding the review volume, results show that it has a positive effect on consumer satisfaction. Looking into each column, the coefficients (β) of review volume are 0.0183 for overall satisfaction, 0.0185 for price satisfaction, 0.0179 for service satisfaction, 0.0181 for accessibility satisfaction, 0.0186 for cleanliness satisfaction, and 0.0180 for facility satisfaction at less than 1% significance level. The coefficients of hashtag volume also provide that it has a positive and significant impact on consumer satisfaction. The coefficients (β) of review volume in each column are 0.278 for overall satisfaction, 0.280 for price satisfaction, 0.283 for service satisfaction, 0.291 for accessibility satisfaction, 0.288 for cleanliness satisfaction, and 0.287 for facility satisfaction at less than 1% significance level. Also, the results above suggest that the positive effect on overall satisfaction by review and hashtag volumes is driven by the positive effects of review and hashtag volumes on all the specific satisfactions. The review and hashtag volume coefficients in columns (1) to (6) are slightly different in magnitude. However, their differences could be neglectable as they are low differentiation. The photo volume did not significantly impact consumers’ perceived satisfaction with this model.

In short, the results in Table 4 show that COVID-19 positively affects overall and other satisfactions. Website information from consumers and hotels also positively and significantly affects perceived satisfaction during the Pandemic outbreak.

Table 4: The impact of COVID-19 on hotel satisfaction

Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)
	Overall Satisfaction	Price Satisfaction	Service Satisfaction	Accessibility Satisfaction	Cleanliness Satisfaction	Facility Satisfaction
COVID-19	1.087*** (0.116)	1.123*** (0.115)	1.079*** (0.117)	1.177*** (0.119)	1.056*** (0.118)	1.031*** (0.116)
Review volume	0.0183*** (0.00311)	0.0185*** (0.00309)	0.0179*** (0.00305)	0.0181*** (0.00318)	0.0186*** (0.00318)	0.0180*** (0.00303)
Photo volume	0.134 (0.0830)	0.136 (0.0830)	0.120 (0.0845)	0.104 (0.0860)	0.0952 (0.0857)	0.0988 (0.0843)
Hashtag volume	0.278*** (0.0258)	0.280*** (0.0254)	0.283*** (0.0256)	0.291*** (0.0262)	0.288*** (0.0265)	0.287*** (0.0258)
COVID-19 severity control	o	o	o	o	o	o
Region control	o	o	o	o	o	o
Constant	-15.53 (143.0)	-15.29 (143.2)	-31.59 (144.2)	-4.183 (143.3)	-15.49 (142.5)	21.01 (140.9)
F-value	26.13***	27.00***	29.94***	31.91***	28.83***	28.82***
Observations	1,018	1,018	1,018	1,018	1,018	1,018
adj. R-squared	0.2359	0.2428	0.2358	0.2431	0.2336	0.2365

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Next, we investigate the moderating effect of star rating on the relationship between COVID-19 and each consumer’s perceived satisfaction. We estimate Eq. (2) to test the moderating effect and report the results in Table 5. Table 5 includes the COVID-19 variable, star, which indicates star rating, and the interaction between them (COVID-19*Star). Columns 1 to 6 present the regression results with various control variables and the fixed effect.

The coefficients of COVID-19 were positively and significantly associated with all consumers' perceived satisfaction at less than a 1% significance level. However, the interaction effect (captured by the coefficient of the interaction term) is significantly negative. Specifically, looking into columns (1), (2), (3), and (5), the coefficients of interaction terms are negative and significant, which are -0.245 for overall satisfaction, -0.230 for price satisfaction, -0.230 for service satisfaction, and -0.242 for cleanliness satisfaction at less than 5% significance level. Also, Columns (4) and (6) show the coefficients of interaction terms are negative and significant, which are -0.244 for accessibility satisfaction and -0.214 for facility satisfaction at less than a 10% significance level. Moreover, consistent with Table 4, the review volume and hashtag volume coefficients in Table 5 are positive and significant at less than a 1% significance level. Also, the coefficient of photo volume shows it is insignificant, which suggests no relationship between photo volume and consumers' perceived satisfaction in this model.

The above finding suggests that website information still positively and significantly relates to consumers' perceived satisfaction and the higher star rating of hotels weakens the positive correlation between the Pandemic and consumers' perceived satisfaction.

Table 5: Moderating effect of star rating

Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)
	Overall Satisfaction	Price Satisfaction	Service Satisfaction	Accessibility Satisfaction	Cleanliness Satisfaction	Facility Satisfaction
COVID-19	1.889*** (0.396)	1.877*** (0.393)	1.877*** (0.396)	1.898*** (0.419)	1.847*** (0.405)	1.730*** (0.396)
Star	0.298*** (0.0827)	0.300*** (0.0815)	0.293*** (0.0824)	0.266*** (0.0863)	0.273*** (0.0844)	0.279*** (0.0820)
COVID-19*Star	-0.245** (0.115)	-0.230** (0.114)	-0.244** (0.115)	-0.220* (0.120)	-0.242** (0.117)	-0.214* (0.115)
Review volume	0.0187*** (0.00308)	0.0189*** (0.00306)	0.0183*** (0.00302)	0.0184*** (0.00314)	0.0189*** (0.00314)	0.0184*** (0.00300)
Photo volume	0.124 (0.0828)	0.125 (0.0829)	0.110 (0.0845)	0.0949 (0.0861)	0.0862 (0.0857)	0.0885 (0.0842)
Hashtag volume	0.266*** (0.0263)	0.266*** (0.0259)	0.271*** (0.0262)	0.280*** (0.027)	0.277*** (0.0270)	0.274*** (0.0263)
COVID-19 severity control	o	o	o	o	o	o
Region control	o	o	o	o	o	o
Constant	-17.38 (142.8)	-17.19 (142.7)	-33.40 (144.1)	-5.832 (143.0)	-17.15 (142.3)	19.24 (140.6)
F-value	25.04***	25.87***	27.62***	28.57***	26.53***	27.09***
Observations	1,018	1,018	1,018	1,018	1,018	1,018
adj. R-squared	0.2438	0.2511	0.2433	0.2488	0.2396	0.2435

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

DISCUSSIONS

Theoretical contribution

Previous literature has adopted quantitative approaches to assess consumers' perception of core hotel attributes during the Pandemic. Exploring consumers' satisfaction has mainly focused on analyzing online reviews and ratings through text-mining approaches on travel platforms. However, this study filled the research gap by making significant theoretical contributions to extant tourism literature from an e-business perspective.

First, our study contributes to the existing consumers' perceived satisfaction during the Pandemic in the hotel sector by identifying the relationship between COVID-19 and various website information that both consumers and hotels have provided. This study highlighted the importance of information that has been provided by hotels, not only the information provided by consumers. The Pandemic is a once-in-a-century global crisis, which provides an important and valuable research context, especially for the tourism sector. This study innovates in detecting how various online information, not only consumers' online reviews, impact consumers' perceptions.

Second, this study newly extracted the data from the Coupang travel platform, from the perspective of the e-marketplace, which had not been considered yet, and used it for research analysis. As the form of e-business gradually diversifies, we tried to consider heterogeneity among online users. Therefore, we classified and analyzed consumers from an e-marketplace, and these attempts offer new possibilities for the generalization and expansion of existing research results.

Third, in addition to expanding the scope of website information and datasets that will affect consumers' satisfaction, it was designed to add further knowledge about existing studies in consideration of previously unobserved cases in Korea. Korea is one of the representative countries where online activities are active and recognized as an exemplary quarantine and response to the Pandemic. Looking at consumers' perceived satisfaction in such an environment, while the influence of other factors on COVID-19 can be relatively minimal, this case can be the group that can observe the relationship between website information and perceived satisfaction relatively clearly in the Pandemic situation.

Practical contribution

This study provides several important practical insights for hotel practitioners regarding information management responses to the Pandemic. During COVID-19, the tourism and hospitality market has influenced the most among other sectors. The uncertainty in this sector has led decision-makers to try to design long-term schemes that survive during the current crisis. Consumers' experiences reflected by online opinions and ratings are vital for both decision-makers to enhance their services and for other consumers to reach the right choice (Nilashi et al., 2022).

From this perspective, this study yields valuable insights for hotel IT managers on how to take appropriate strategies for providing their photos and hashtag information. Specifically, the number of reviews and hashtags significantly positively affected consumers' satisfaction perception, confirming that hotel managers should try to provide more detailed hotel-related information to consumers. In addition to managing online review information from other consumers who are in the same position, hotel managers should recognize that potential consumers are also paying attention to small details such as hashtags provided by hotels.

Second, especially in the e-marketplace platforms, this study allows hotel representatives to consider consumers by platform type. Specifically, hotel representatives may consider understanding the characteristics of consumers according to the platform the hotel is promoting. This effort will provide opportunities for hotels to find similarities and differences among consumers on different platforms and how to market depending on the targets.

Third, maintaining the quality of the provided services was indicated as an essential driver of consumers' perceived satisfaction in this study. It is found that consumers not only evaluate themselves when evaluating the attributes of a hotel, but also the overall impact of COVID-19 and the environment are affected either consciously or unconsciously. This is referred to the fact that consumers are worried about their safety and health, which presents significant insights for hotel managers. It is expected that even after the Pandemic ends, attribute measures will be essential dimensions in the quality of the services, in which hotel managers will be more flexible to unexpected conditions.

Limitations of research and future work

Although this research has several theoretical and practical contributions, the research also has a few limitations that should be addressed and allows future research directions to be followed. First of all, a major assumption of this study is that there is no difference in the services provided by hotels before and during the Pandemic. Therefore, in order to make this assumption strong, it is necessary for researchers to examine whether each hotel provided services of the similar quality.

Also, one of the contributions of this study is that it deals with the dataset of the e-marketplace platform rather than the existing specialized travel platform. However, there is a limitation of this dataset as the small sample size. In particular, the proportion of the e-marketplace platform's consumers is not large enough in terms of the hotel sector. Therefore, it is necessary to utilize more accumulated datasets in the future.

In addition, according to the dataset's characteristics, only national consumers were considered in this study. In the future, using the global e-marketplace dataset will help broaden this research field's generalization. Furthermore, it analyzed only the perceived satisfaction of consumers of e-marketplace and did not perform a comparative analysis with other platform consumers. An additional comparison process will help researchers ensure the study results' robustness.

Finally, it would be a good approach to collect primary data such as interviews or surveys from relevant reviewers from the platform and compare them with online data results. While this study only focused on establishing variables by volume for each information, the text-based analysis could be helpful in the future.

CONCLUSION

This study explored the impact of COVID-19 and website information on consumers' perceived satisfaction in the hotel industry. It shed some light on investing whether star rating has a moderating effect on consumers' perceived satisfaction. While previous studies focused on analyzing consumers' satisfaction with specific travel platforms, this study tried to fill a research gap by collecting data from an e-marketplace platform and providing exploration to be generalized to other contexts in a big e-commerce concept.

Consequently, the results stated that consumers' perceived satisfaction differed before and during COVID-19. There was a moderating effect of star rating, and perceived satisfaction tended to decrease as the star rating increased. Furthermore, the

volume of reviews and hashtags that consumers and hotels provided positively affected perceived satisfaction. Even though there are some basic assumptions and limitations, this study emphasizes the necessity of exploring the e-marketplace approach, considering website information in the tourism literature from an e-business perspective.

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The impact of emotionally negative online reviews on consumer purchase intentions

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ABSTRACT

Online reviews are an important factor influencing consumers' purchasing decisions. However, there is no literature to explore the mechanism of emotional negative online reviews on consumer purchasing behavior. The research results enrich the theory of user information behavior, and have practical significance for merchants' precision marketing and customer relationship management. Based on ELM theory and regulation focus theory, using the method of situational experiment, from the two paths of peripheral situation perception and core cognitive processing, explore the influence of regulation focus on consumer purchase intention under the stimulation of emotional negative online reviews effect. The research results show that: under the stimulus of negative emotional online reviews, prevention of targeted consumers is mainly affected by the emotional arousal of the edge path, and positively affects purchase intention through emotional response; promotion of targeted consumers is mainly affected by the perception of the central path. The influence of effort positively affects purchase intention through cognitive response; among them, emotional response has a greater leading role in purchase intention.

Keywords: Emotional online reviews, ELM theory, regulation focus, purchase intention.

INTRODUCTION

Online reviews can be classified as positive reviews and negative reviews. According to the existing research, negative reviews tend to exert more significant influence on consumers' behavior. Nowadays, with daunting amount of automatic default praises or fabricated praises from 'click farm', the favorable rate of E-commerce sites has been constantly holding up, which threatens to interfere the purchasing decision of consumers to a large degree. As a result, there has been a tendency that consumers afford more trust to the commodities which involve negative reviews than to those without negative reviews. Negative reviews can be classified as two categories. One is objective negative reviews, which contain little emotional tone; the other is the contrary, namely the emotional negative reviews, which involves expression such as 'That's ridiculous', 'Bah! It's terrible' or 'Not satisfied'. Without being instructed about how to write comments, reviewers prefer to share their sentiment concerning commodities. According to Sweeney, negative reviews contain 63.6% emotional factors and 15.9% cognitive factors. Thus, it has become an important research direction to explore the impact of emotional negative online comments on consumer psychology and information behavior in order to better grasp the laws of consumer behavior.

When processing information, consumers will be affected by personality traits, and their behavior depends on the individual's information processing methods, as a result of which different consumers will choose their preferred strategies when making decisions. There are two issues escaping from the attention of researchers: 1. in the context of e-commerce shopping, do consumers with different personality traits have different information processing paths after reading emotional negative comments? 2. what is the underlying cause of discrepancies of information processing behavior and how it influences consumers' purchasing intention. With use of situational experiment, our research explores the different influence paths of cognitive effort and emotional arousal on the purchasing intention of promotion focused and prevention focused consumers respectively, breaking through the rational person hypothesis and considering the influence of limited rationality and cognitive bias. The research not only promises to enrich the theoretical system of information users and consumer behavior, but also of great practical significance to the precision marketing of merchants.

LITERATURE REVIEWS & THEORETICAL BASIS

Emotional negative online reviews

Researches concerning online reviews mainly focus on two aspects, the usefulness of online reviews and the influencing factors behind consumers' behavior. The former identifies the usefulness and its influence on purchase intention based on objective features, such as the number of reviews, star ratings, the length of reviews, timeliness of reviews and quality of reviews, et al. E.g., Mudambi and Schuff constructed a measurement model of the usefulness of online reviews by comment extremes and comment lengths based on the decision uncertainty framework, defining the concept of online review usefulness. The latter explores the attitude and behavior of consumers in sentimental scenario of bounded rationality which involves sentimental polarity and intensity. The online review written by consumers after purchasing often contain different emotions such as happiness, love, sadness or disappointment, which will be perceived by potential consumers to varying degrees,

correspondingly affecting their purchase intention. Thus, discrete emotions have been pivotal factors worthy of attention. Some studies have shown that the perceived usefulness obtained from online reviews will positively affect consumers' attitudes towards decision-making. In particular, comments with emotional expressions are more persuasive to consumers with emotional appeals. Negative emotions can significantly promote sharing behavior of negative IWOM, among which the anger of consumers pose a positive impact on information sharing behavior.

In scenario of informatics, existing researches concerning sentimental information behavior mainly focus on two aspects: 1. Exploring the relationship between audience behavior and emotion, where emotion serves as the argument. E.g., Tu Hongwei explored the impact of consumer anger on travel intention and negative word-of-mouth communication by constructing a model mediated by trust, discovering that self-efficacy has a moderating effect between emotion and trust. 2. Exploring the mediatorial role of emotion in the process of audience behavior, where the features of information, such as credibility, usefulness and quality, et al., serve as the argument. After being processed by consumers, information will affect the behavior of users via communication of emotion. In previous studies, scholars generally recognized that information is the stimulus of emotion, but ignored the fact that information can also be the carrier of emotion. In particular, the research on how emotional online comments affect consumer behavior is rather insufficient.

The existing research focuses more on the discussion of the usefulness of online reviews, while they rarely explore the influence of negative reviews on persuasion and consumption decisions based on the emotional arousal in negative reviews. E.g., from the perspective of usefulness, Yin et al. found that online reviews with negative emotions of worry and anxiety required more cognitive effort than online comments with negative emotions of anger, which made consumers perceive more usefulness and increased persuasive effect. The perception of the usefulness of comments can enable consumers to identify information that is helpful to them from tons of comments. However, the perceived usefulness is only a pre factor of attitude and behavior intention. The relevant literature does not pay attention to the relationship between emotion and behavior intention. There is a lack of systematic thinking on the mechanism and influence process of emotional negative reviews in consumer behavior through both cognitive and emotional paths. It's insufficient to classify online reviews as positive ones and negative ones as existing researches do. Since emotion is usually associated with two or more major evaluation dimensions and the same type of emotion will have the same potency on attitude, some scholars analyze negative comments of different dimensions according to the difference of emotion intensity. E.g., based on emotion ontology, Zheng Lijuan et al. used context to analyze the emotional polarity and intensity of online reviews, and extracted the characteristic words "very bad" and "a little bad" as the classification criteria for the emotional degree of negative reviews, so as to explore the impact of emotional negative reviews on consumers' behavior, which provides us with reference of methods.

Existing researches concerning information behavior of consumers illustrate that emotional reviews of online word of mouth can speed up the dissemination and sharing of information. The emotion of reviewers can affect the emotion of potential consumers through emotional infection, thus affecting their behavior. However, the existing research has not clarified the relationship between emotion and behavior in negative reviews. E.g., Xu Ying et al explored the different effects of content presentation characteristics on information penetration behavior from the two action paths of emotion and cognition, and found that the information penetration under the cognitive path has a significant impact on behavior; Jin Xiaoling et al constructed a path model of emotion to impulsive sharing behavior in social media and found that the emotional valence dimension affects impulsive sharing behavior of online audiences. In addition to the audience's own cognitive evaluation, scholars have found that emotional arousal in the concept of emotion has a significant impact on the audience's behavior. E.g., Berger believes that it is not comprehensive to consider only the emotional valence dimension when analyzing audience behavior, and the content of emotions with high wake-up characteristics is more convincing and credible. However, studies on online reviews only consider the impact of positive and negative emotions on consumer behavior in scenario of emotional valence, while the impact of emotional arousal dimension still escape from attention.

According to different goal pursuit and risk preference, different personality traits of consumers lead to different self-focus strategies of individuals, resulting in different psychological perception and behavior choices. Liu Luchuan et al found that negative reviews with different emotional intensity have different effects on consumer attitudes, which is regulated by individual characteristics of consumers. It is manifest that emotional reviews can affect consumers' attitudes and behaviors, which are affected by different personality traits, and their internal behavior path selection remains the focus of future research. However, the impact of consumers' personality traits and psychological needs on their information behavior is subjective and can hardly be changed easily, while consumer perception, such as emotion and cognition, can regulate and change this impact. In order to deeply study the impact of consumer perception and personality traits on behavior, we try to obtain the perception factors from emotional negative reviews, divide the consumer population and analyze the path function of individual information processing and the impact of consumer perception on consumer purchase intention

Existing researches concerning emotional information put more emphasis on the phenomenon of emotional communication of informatio, exploring the contributing factors and influence of emotional information and summarizes the rules of emotional communication through text mining or modeling work. However, these studies have not explored the impact mechanism of emotional information on consumers' purchasing behavior, and lack of empirical research on the explanation for the more persuasiveness of emotional information and the factors affecting emotional persuasive effect. The existing research lacks in-depth discussion on the emotional and cognitive changes of consumers under the stimulation of specific situations and the

choice of information paths under the influence of personality traits. As a result, in order to grasp the dynamic changes of the influence of the external environment on information behavior through consumer psychology, our research adopts the method of situational experiment. According to the ELM framework in the process of information reception and considering the characteristics of consumers, we explore the mechanism of the information processing process of consumers of different regulatory focus types under the stimulation of emotional negative comments from the central path and the marginal path respectively, revealing the effects of emotional arousal and cognitive effort on consumers' emotional and cognitive responses, and the boundary conditions of the two factors on the final purchase intention. The research not only promises to enrich the theoretical system of information users and consumer behavior, but also of great practical significance to the precision marketing of merchants.

Elaboration Likelihood Model

Elaboration Likelihood Model (ELM) has been widely used in research fields of attitude, social communication and consumer behavior to explain the forming process of attitude and strategies of processing information. According to ELM theory, there are two basic paths of persuasion: central pathway and peripheral path. When the individual has high motivation and ability, they tend to resort to the central path of rational cognitive factors. Most of them evaluate and receive information by examining the information source, relevant experience and evaluation, and then change their attitude; When one of the motivation and ability is insufficient, they tend to resort to the marginal path of peripheral factors, respond to the stimulation according to the association and emotional experience caused by the information demand, and process the information through intuitive judgment. Pallak believes that the content of external information is closely related to the path choice of potential consumers: the central path is activated when consumer process cognitive information, and the marginal path is activated when consumer process emotional information. However, during consumers process online comment information, the influence of external information on behavior through consumer psychology and the influence of consumer psychological characteristics on information behavior may change with the change of different factors, and user characteristics, such as consumer personality traits, may also affect or change their consumption decisions. Li Zhong et al found that not all consumers process information carefully. Under certain circumstances, consumers will unconsciously choose the information processing path they recognize according to their own judgment. Petty and Cacioppo also found that the information processing methods of the central path and the edge path can be transformed, but whether they prefer the central path or the edge path, the resulting attitude change will ultimately affect consumers' purchasing behavior. Therefore, when processing emotional information, different information receivers will produce different information processing paths: different individuals tend to perceive the factors of individual preference from the information framework, which will be the logical basis for the final decision.

For the persuasive information of online comments, consumers who are the objects of persuasion will have two types of reactions: cognitive response and emotional response. The former tends to perceive rational factors from the information and use objective cognition and knowledge reserve to process the content of comments, while the latter tends to perceive perceptual factors from the information and mainly processes persuasion information through emotional arousal, situational perception or personal value mobilization. Based on ELM theory, Gong Yanping discusses the impact of negative online reviews on consumers' adoption intention from the central path and the marginal path, discovering that the impact of online reviews on consumers plays a role only through the central path. Lee et al used ELM theory to explain the impact of the quality and quantity of negative online reviews on consumer behavior, and explored the moderating effect on consumer of different involvement degree. Gan Zhen found that the central path and the peripheral path can affect consumers' intention to use online travel websites, and the involvement degree plays an important moderating role in consumers' choice of website information processing methods. Through two-stage experimental research, Shan Chunling et al found that consumers with high contradictions change their attitudes along the central path, and the degree of inclination to follow the opinions of commentators will be determined according to the quality of comments, while those with low contradictions change their attitudes along the peripheral path, which is significantly affected by the number of comments. However, there has been no study revealing the specific path between psychological perception and emotion, cognition and behavior of consumers with different regulatory focus types under the influence of emotional online reviews. Therefore, based on elaboration likelihood model, we divided the influence process of emotional negative reviews information on potential consumers' purchase intention into the peripheral context perception path and the central cognitive processing path, exploring the different influence paths of cognitive efforts and emotional arousal on the purchase intention of promotion focused and prevention focused consumers.

RESEARCH HYPOTHESIS AND MODEL

Emotional arousal degree and perceived cognitive effort

There have been a plethora of researches revealing that the emotional dimension mainly involves valence (i.e., pleasure) and arousal (i.e., the degree of emotional activation). Relevant studies also focus on the "Valence-Arousal" two-dimensional model. Although emotional valence has an important impact on decision-making, some studies have found that the decision-making results are inconsistent even when the potency is consistent. Stefanucci et al found through a series of experiments that emotional arousal can regulate individuals' high perception compared to valence. Subsequently, arousal was widely studied as an important dimension of emotion. E.g., Yuen and Lee studied the influence of different emotional arousal levels on risk-taking tendency, where they found that high emotional arousal people tend to hold a more cautious attitude towards risk than those with low emotional arousal. Studies have found that high-intensity emotions narrow the scope of cognitive processing, interfere with information processing and self-control, etc., in particular, the arousal of negative emotions is more likely to make such information penetrate our memory system, thus strengthening the final behavior. In addition, different levels of

perceived emotional arousal will affect individual preferred decision-making and behavior. E.g., Wang Lei et al believe that reviews with high arousal level tend to exude high certainty and confidence, which is more likely to repeatedly strengthening psychological cues for consumers in complex information. Existing studies show that the expression of online reviews can affect consumers' emotional response by triggering interaction with consumers. Due to the lack of language, facial expression and other clues, online reviews can merely rely on emotional words, content quality and other necessary factors to promote emotional response. Lee believes that consumers will process information by emotion to a greater extent, if the emotional arousal level of consumers is affected by emotional expression in online reviews. Because emotional reviews can usually be used as an information clue to directly affect decision-making and judgment, when expressing positive and negative attitudes, the expression of high arousal level makes the audience feel stronger attitude proclivity, and the information audience will observe and experience the emotions consistent with the communicators vicariously and stimulate their emotional reactions. In the light of these statements, we propose the hypothesis as follows:

H1: Emotional arousal positively affects emotional response.

Cognitive effort is the energy and time cost paid by reviewers when writing reviews and cognitive response is the idea generated by consumers after processing information. Information obtained from information sources will measure the level of cognitive effort by diverting attention and reallocating cognitive resources, and change attitudes through consumer response. Consumers will choose the relevant evaluation information of products as the main information source when shopping online. After browsing the online comments, potential consumers will make subjective judgments and generate purchase intention through cognitive processing at the psychological level. For the two different kinds of review information mentioned above, the cognitive effort perceived by potential consumers will also be different. Traditional studies believe that emotion is an obstacle to rational thinking. However, emotion plays an important role in information transmission, so their impact on cognitive tasks is also variable. That is to say, the different degree of emotion will affect consumers' perception of reviewers' cognitive efforts. E.g., Yin et al believe that anxious reviewers spend more energy and time, and pay more cognitive efforts, while angry ones do not think carefully, put less energy into writing comments, and pay less cognitive efforts. Moreover, potential consumers will naturally believe that the experience description built with more effort is more complete, more authentic and more likely to change their attitude. Therefore, based on the different perceptions of potential consumers on cognitive efforts, reviews with higher levels of cognitive efforts are accepted as involving more comprehensive, detailed and effective information and are more logical, thus exerting more persuasive influence on potential consumers. In the light of these statements, we propose the hypothesis as follows:

H2: Cognitive effort positively affects cognitive response.

Consumer cognitive and emotional reaction and purchasing intention

Existing research holds the view that attitude includes three dimensions: cognition, emotion and behavior. Consumer attitude is a cognitive and emotional response produced by the consumer exposed to various external stimuli. The behavioral intention component represents the possibility and inclination of an individual to take a certain behavior to express his attitude towards a certain product. In marketing, it usually refers to the purchase intention; cognitive response usually refers to the thoughts, opinions, knowledge and beliefs generated by positive thinking during or after the thinking process; emotional response refers to an individual's emotional attitude produced by external stimulation. In this paper, cognitive response refers to the feeling, memory, thinking and perception of understanding and reasoning generated by consumers after browsing online reviews with different emotional levels, such as the judgment of product quality; emotional response refers to the emotional response formed by an individual based on previous experience and judgment of emotional perception of content after browsing reviews, such as the degree of love for products.

Emotional information is more likely to be perceived by consumers, contributing to their attitude change. In scenario of consumer behavior, some studies have found that the cognitive component of individuals and the emotional component of tactile stimulation are the basis of consumers' purchase intention. Some studies have also found that when consumers are faced with a large amount of uncertain information, they tend to use emotional cues to search for available information, and ease uncertainty and anxiety under information overload through emotional perception of information transmission. Therefore, consumers will process emotional negative comments through motivation attribution, which will produce different cognitive and emotional responses. For example, impulsive purchase behavior is a typical consumer information processing method dominated by emotional responses, and this emotional response of marketing stimulation will promote consumers' spontaneous purchase intention. Some scholars have developed and empirically established a model combining emotional response with the cognitive dimension of commodity evaluation, and found that in addition to cognitive factors, emotional responses through sensory cues also affect their quality perception. Gao Lin et al also confirmed that the argument strength and validity of online reviews will positively affect consumers' emotional response, and the ability, reliability and activity of information sources will positively affect consumers' cognitive response, while consumers' emotional and cognitive responses will promote consumers' purchase intention. Therefore, the different reactions of consumers will ultimately affect their purchasing intention. In the light of these statements, we propose the hypotheses as follows:

H3a: Consumer's cognitive reaction positively affects their purchasing intention;

H3b: Consumers' emotional reaction positively affects their purchasing intention.

Moderating effect of regulatory focus

Previous studies have found that consumers' purchasing intention is not only related to the usefulness and quantity of online reviews, but also moderated by individual characteristics, such as cognitive ability, product involvement, and personality traits, et al. Due to the difference of consumers' personal preference, information sensitivity, cognitive level and professional knowledge, consumers' information interpretation ability and processing ability are also different. This heterogeneity will affect consumers' perception of risk and their attitude to information retrieval, thus affecting consumers' perception. Higgins put forward the regulatory focus theory, which divides the consumer groups into two types: promotion focus and prevention focus. He believes that promotion focused consumers are optimistic and positive, habitually adopt the strategy of 'desire-approach', pay more attention to the positive results of things, and are willing to change. They will exude low risk aversion in behavior and improve their decision-making; preventive consumers are prudent and cautious, habitually adopt the strategy of 'vigilance-avoidance', pay attention to the negative results of things, do not like changes, pay attention to safety, show high risk aversion in behavior, and pay attention to defense in decision-making.

Regulatory focus can be used as a universal motivation principle to explain the differences in individual's psychological processes such as cognitive evaluation, behavioral strategies, and processing methods, regardless of being short-term or long-term. In many fields, regulatory focus has been applied to explore the motivational origin and behavioral outcomes of individual goals and their effects. At the same time, existing research has shown that regulatory focus has a close relationship with individual emotions. promotion focused individuals are more inclined to produce subjective feelings of joy and frustration, while preventive ones are more likely to produce subjective feelings of relaxation and anger. When facing negative online reviews of different moods, different individuals can more easily capture the corresponding emotions. Moreover, researchers found that when the form of information presentation is consistent with the regulatory focus individual, the strong sense of correctness generated by the individual would interfere with the purchasing intention. This means that the regulatory focus has a guiding effect on individual behavior. This regulatory matching will make consumers produce different information processing processes, and thus better reconciling the relationship between consumer reaction and behavior from the perspective of thinking mode and information processing.

The diverse thinking mode of consumers with different focused types will lead to some different behavior changes after negative experiences. Consumers in the negative experience situation will have different cognitive and emotional reactions to the negative experience. Under the auxiliary judgment of the product, they search and compare the information stored in the brain, and form the final evaluation of the product through their own cognitive processing process. In other words, consumers will have different reaction after receiving information, but when it comes to specific personal behaviors, consumers will make decisions again through the information processing process. For example, there are often such individual experience in daily life that even when consumers receive similar information, they may not have a consistent purchasing intention. Thus, emotional information is processed using peripheral paths is not applicable to all consumers. In the past, the general explanation for the greater impact of emotion (or cognition) on consumer behavior ignores the differences of individual characteristics of consumers, which may be personality, living habits, etc. Therefore, this will have a certain impact on the final decision-making of consumers. As the promotion focused consumers have higher cognitive needs, they are good at capturing the deep abstract information between things, while the prevention focused consumers are good at handling specific information and making decisions by capturing the corresponding deterministic emotions. Moreover, we believe that the information preference of different consumers will be more manifest, and the boundary of route selection will also be strengthened under the negative reviews containing emotions. Therefore, according to the ELM theory, compared with the promoting consumers, the preventive consumers are more inclined to the peripheral information processing mode: process information by perceiving the emotional intensity in the reviews, which will significantly strengthen the negative behavior on the basis of the emotional response; Compared with preventive consumers, promotion focused consumers tend to use higher cognitive ability, adopt the central information processing method, use independent thinking ability to judge logic and persuasion: process information through cognitive efforts in perceived reviews, which will significantly strengthen negative behaviors on the basis of cognitive response. In the light of these statements, we propose the hypotheses as follows:

H4: Different types of regulatory focus have different effects on consumer reaction and purchasing intention.

H4a: When reading emotional negative reviews, the more remarkable the characteristics of preventive individuals, the stronger the influence of emotional response on purchasing intention;

H4b: When reading emotional negative comments, the more remarkable the characteristic of promotion focused individuals, the stronger the influence of cognitive response on purchase intention

Based on the above assumptions, we establish the model according to the center and peripheral paths, as shows in Figure 1.

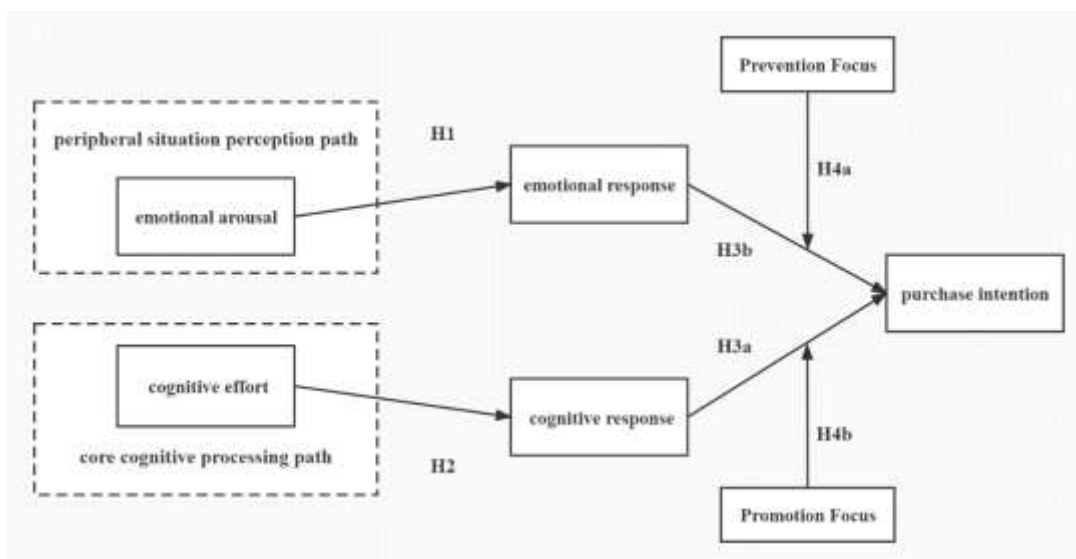


Figure 1: Theoretical research model.

RESEARCH METHOD

In order to verify the real reaction of consumers browsing emotional negative reviews, we use scenario situational experiment to collect data and verify hypotheses. The stimulus material was adapted from the negative reviews on Taobao website. The experiment was divided into four stages, including scenario simulation, questionnaire design, pre-test, and data collection.

Experimental purpose

The main purpose of the experiment is to verify the impact of emotional arousal and cognitive effort on consumer response facing emotional negative reviews, and to explore whether different consumers are more likely to rely on emotion or cognitive response to make final behavioral decisions. In order to control the subjects' attitude change caused by negative reviews, the experimental process is divided into pre-test and post-test, and the difference between the two experiments is taken as the data source for processing.

Experimental design

As college students are the main force of online shopping and have strong homogeneity, we chose college students with online shopping experience as the experimental subjects. In this experiment, 4G mobile phones are selected as the experimental target. As search products, 4G mobile phone enable consumers to know the quality and performance through search and query before purchase. Meanwhile, college students are highly engaged with mobile phones and will not be disturbed by product knowledge factors and involvement.

There are a variety of emotional words in online reviews. Our research refers to the classification method of emotional words by Zheng Lijuan et al. At the same time, in order to ensure that the subjects have different degrees of emotional arousal and perceptual cognitive efforts, negative comments with strong and medium emotional intensity were designed as stimulus materials for emotional negative online reviews. In the real setting of online shopping, there is often a mixture of positive and negative information in the commodity reviews. In order to further restore the authenticity of the online shopping and avoid the strong stimulation of the negative reviews on the subjects, two groups of stimulation materials were set up in the experiment, with six reviews in each group. We put manipulated reviews (ones with strong emotional intensity and ones with moderate emotional intensity) in positions 2, 4 and 6 in each group. In other words, in each group, the three positions show the same type of reviews, and each sentence is fixed at 112 words. Filler comments are regular positive reviews positioned in 1, 3, 5 in each group, and each sentence is fixed at 30 words. E.g., 'I like their website', 'There are many items all of which has a good description', 'I received exactly what I ordered online'.

The first step is to compile the negative reviews. Since the negative reviews involve a lot of content, we compile them based on the real reviews from users of Taobao and Jingdong. After the statistics of the negative reviews on Taobao and Jingdong, it is found that the negative comments are mainly concentrated on products, services and logistics. Product quality problems mainly involve mobile phone touch effect, battery life, black screen, laggings; the service problems mainly involve poor service attitude of the shopkeeper, improper after-sales treatment, and failure to solve problems in a timely and effective manner; Logistics problems mainly involve slow delivery speed, slow logistics speed, damaged goods, poor attitude of courier. Since different people attach different degree of attention to products, services and logistics, in order to control the experimental variables, each group of reviews only involves the product quality. We chose and sort out 58 negative reviews including mobile phone touch effect, system installation, black screen, laggings and battery life, deleting extremely short or long reviews. After that, we interviewed 20 participants and found that the emotional words such as 'bah', 'ridiculous', 'terrible', will contribute to different emotion intensity perception. Therefore, when compiling the reviews, we use the words containing "anger", "terrible" and other relevant words as the source of the sentence structure of negative emotional reviews. In

order to mute the influence of other variables on the persuasiveness of selected comments, the usefulness and quality of reviews should be regulated during the preparation

Workflow

Before analysis, we conducted a manipulation test on the stimulus materials to ensure that the subjects can identify the emotional intensity of negative reviews, so as to generate different levels of consumer perception (emotional arousal and cognitive effort) and ensure the smooth progress of the experiment. Before the formal experiment, we invited 40 subjects to browse the two groups of prepared stimulus materials, each of which contains six pieces of positive and negative reviews. Then the subjects will be required to finish question, "fill in the negative emotion value of this review", with a range of 0-100 points, to test the subjects' judgment on the emotional degree of negative reviews in stimulus materials. The results show that the mean value of emotional negative reviews with strong and medium emotional intensity is significantly higher than that of those without emotional words ($M_{strong}=65.12$ vs $M_{none}=42.30$, $F=30.12$, $P<0.01$; $M_{medium}=60.96$ vs $M_{none}=39.29$, $F=37.42$, $P<0.01$) , demonstrating that the two groups of stimulus materials meet the experimental requirements of emotional negative online reviews.

The emotional dimension includes valence and emotional arousal. In order to exclude the alternative explanation of valence to the experimental results and to control the impact of valence on consumer behavior in the data analysis, a valence scale was added to the experimental questionnaire. The test is divided into pre-test and post-test, with an interval of two weeks. The subjects were invited to the laboratory and each of them had a computer and the situation was that the subjects buy a 4G mobile phone online for themselves. By letting the subjects browse the pictures and product descriptions of a new product and online reviews of other consumers, they were exposed to the real online shopping setting. In the pre-test experiment, the participants were first shown the basic introduction of mobile phones and three positive reviews, and filled in the relevant questionnaires, including the personality trait scale, consumer response and purchasing intention scale. In the post-test experiment two weeks later, the subjects browse the prepared stimulus materials which include six pieces of positive and negative reviews, and fill in the consumer response and purchasing intention scale, emotional arousal scale, perceived cognitive effort scale, and potency. Finally, fill in the relevant demographic information.

DATA ANALYSIS AND PROCESSING

Sample statistics

211 subjects were recruited in this experiment. 5 questionnaires were excluded from the pre-test and 19 questionnaires were excluded from the post test. The final effective questionnaire was 187, with an effective rate of 88.6%. Among the effective questionnaires, 101 were female, accounting for 54%, and 86 were male, accounting for 46%. The participants are between 18 and 30 years old, have more than 2 years of online shopping experience.

Examination of Reliability and Validity

Since Smart PLS has good model fitting effect on small sample data, we adopted Smart PLS for data processing. The data were tested for reliability and validity, and the results showed that all the croubach's α are greater than 0.7, and the AVE values are greater than 0.5, which indicates that the scale has good reliability and convergence validity, and the square roots of all AVE values (bold numbers on the diagonal in the table) are greater than the correlation coefficients among the constructs. (Table 1)

Table 1: Root mean square of correlation coefficient and mean extraction variance of constructs t.

	EA	CE	CR	ER	BI	PRO	PRE	V
EA	0.915							
CE	0.280	0.938						
CR	0.397	0.440	0.893					
ER	0.414	0.289	0.744	0.879				
BI	0.336	0.195	0.631	0.730	0.861			
PRO	-0.044	-0.083	-0.240	-0.251	-0.117	0.806		
PRE	0.064	0.111	0.235	0.282	0.267	-0.137	0.832	
V	-0.307	-0.120	-0.204	-0.134	-0.015	0.057	0.061	0.911

Note: The value on the diagonal is the root mean square of the AVE value of each variable, and the other values are the correlation coefficients between each construct.

The total variance of the cumulative interpretation of the model is 55.2%, indicating that the emotional and cognitive responses generated by consumers after reading negative comments of different intensities have a good explanatory power on consumers' behavior. To further explore the effects of each latent variable, we measured Q^2 and f^2 respectively, the result of which can be seen in Table 2. Since $0.15 \leq f^2 \leq 0.35$, it indicates that the path effect is in the medium effect and has good influential effect; since $Q^2 > 0$, it indicates that the variables of the model have predictive power to the endogenous latent variables.

Table 2: Q2 and f2 in path of model

Path	f ²	Q ²	Path	f ²	Q ²
E A → ER	0.19	0.12	ER → BI	0.34	0.37
CE → CR	0.24	0.23	CR → BI	0.16	0.12

Hypothesis test

We applied central processing method to the data and found that emotional arousal positively affects emotional response ($b_{EA*ER}=0.41$, $P<0.001$), perceived cognitive effort positively affects cognitive response ($b_{CE*CR}=0.44$, $P<0.001$), emotional and cognitive responses positively affect purchase intention ($b_{ER*BI}=0.59$, $P<0.001$, $b_{CR*BI}=0.31$, $P<0.05$). The result confirms the hypotheses H1, H2 and H3. By comparing the effect of emotional response and cognitive response on purchase intention, it is found that emotional response has a more significant effect on purchasing intention than cognitive response. This also demonstrates that attitude based on emotion has a stronger predictive power on purchase intention, and emotion tend to plays a dominant role in behavior. In the light of these statements, consumers cannot make rational decisions actually, and their behavior is often accompanied by emotional impulse and perceptual thinking. Moreover, the study found that emotional arousal and valence will jointly affect consumers' emotional response. In order to explore the impact of valence, the processed data tells that the relationship between potency and emotional response was not significant ($b_{V*ER}=-0.15$, $P>0.05$). In order to test the moderation effect, we set valence, gender, age, education, Internet age and online shopping age as controlled variables with the application of AHP, constructing product interaction terms of emotional response and prevention focus (ER * PRE) and cognitive response and promotional focus (CR * PRO) respectively, the result of which is showed in Table 3. After four times of regression, R² witnesses an increase of 0.387, from 0.175 to 0.562, indicating that the more significant the trait of the promoting individual, the stronger the influence of cognitive response on purchasing intention; the more significant the characteristics of preventive individuals, the stronger the influence of emotional response on purchasing intention. This precisely justifies the hypotheses H4、H4a、H4b.

Table 3: Results of analytic hierarchy process

Item	Variables	Purchasing Intention			
		Model1	Model2	Model3	Model4
Controlled Variables	Gender	0.025	0.016	0.132	0.062
	Age	0.032	0.064	0.058	0.055
	Education	-0.121	-0.217	-0.233	0.186
	Internet Age	0.092	0.136	0.242	0.196
	Online Shopping Age	0.234	0.147	0.349	0.150
	Valence	-0.160	-0.233	-0.179	-0.303
Argument and Moderators	EA		0.129***	0.157***	0.122***
	CE		0.212**	0.342***	0.200***
	ER		0.465***	0.656***	0.541***
	CR		0.203***	0.438***	0.205**
	PRO			0.241*	0.202*
	PRE			0.311*	0.204
Moderating Effect	ER*PRE				-0.210*
	CR*PRO				-0.143*
	R ²	0.175	0.428	0.519	0.562
	△R ²		0.253	0.091	0.043

Note: *P<0.05, **P<0.01, ***P<0.001.

A two-way ANOVA was conducted to analyze the impact of consumers' cognitive and emotional responses on the subjects' purchasing intention when the consumers were prevention focus or promotion focus. The results showed that the data of cognitive response and emotional response under emotional negative reviews were regressed with the types of regulatory focus. The interaction of promotion focus and cognitive response had a greater effect than the interaction of prevention focus and cognitive response ($b_{PRO*CR}=0.48$, $P<0.05$; $b_{PRE*CR}=0.21$, $P<0.05$); on the contrary, compared with the interaction of promotion focus and emotional response, the interaction of prevention focus and emotional response had a greater impact ($b_{PRE*ER}=0.65$, $P<0.05$; $b_{PRO*ER}=0.34$, $P<0.05$). As can be seen from Fig. 2 and Fig.3, the cognitive response of promotion focused ones can make them produce greater purchasing intention, while it turns out to be the emotional response when it comes to prevention focused ones.

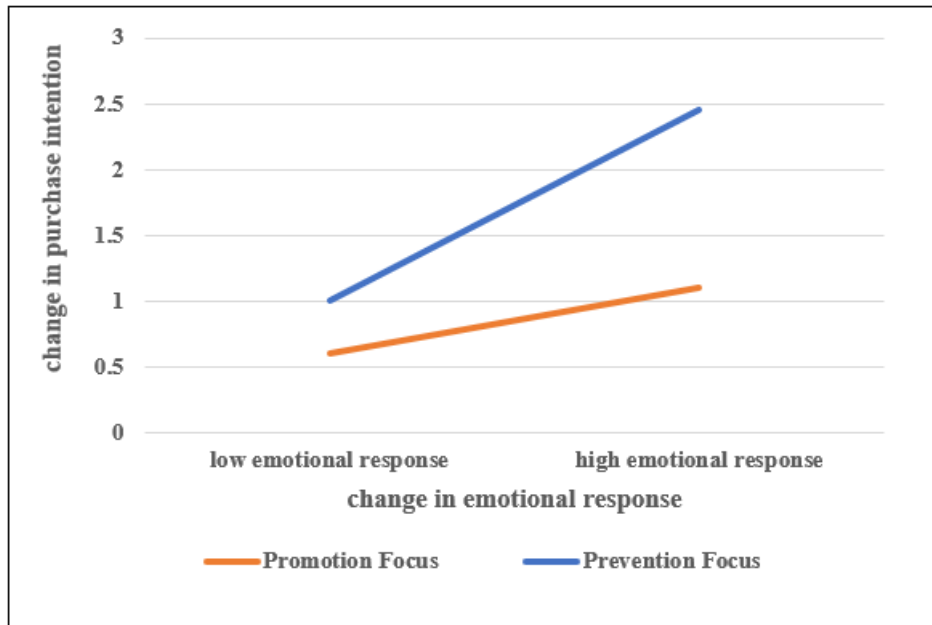


Figure 2: The moderating effect of regulation focus on the relationship between emotional response and purchase intention.

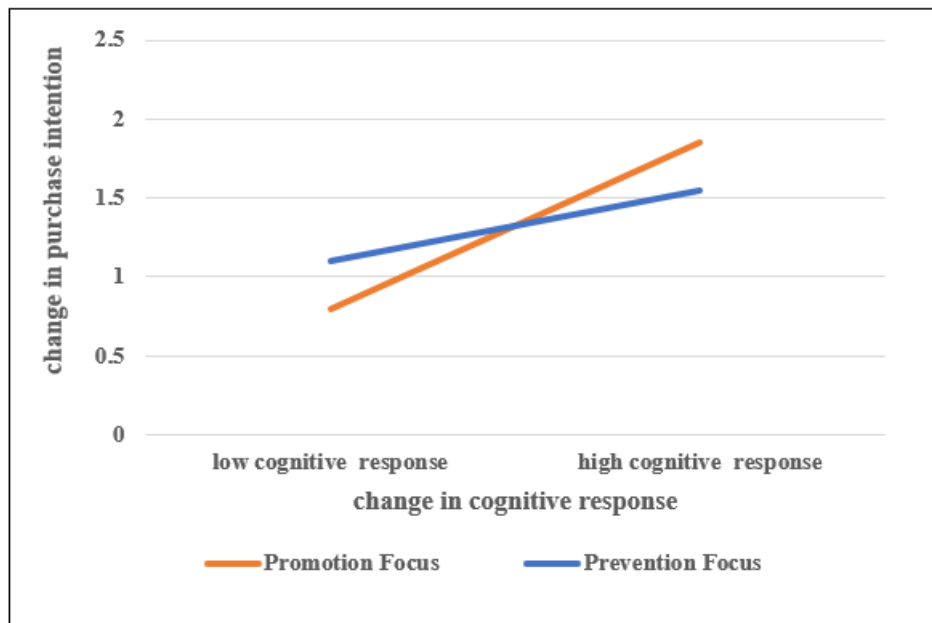


Figure 3: The moderating effect of regulation focus on the relationship between cognitive response and purchasing intention under the emotional online reviews

CONCLUSION AND PROSPECT

Research conclusion and theoretical contribution

Consumers tend to cover different emotions when expressing negative reviews. Then, will all consumers adopt the same information processing method when facing these reviews? What factors do consumers perceive when processing information? This study uses experimental scenario simulation to explore the influence of regulation focus on consumers' purchasing intention in the face of emotional online reviews, and reveals the mechanism and boundary conditions of the influence. The experimental results show that: (1) the prevention focused consumers are mainly affected by the emotional arousal of the peripheral path, and the purchasing intention is positively affected by the emotional reaction; (2) The promotion of targeted consumers is mainly affected by the cognitive efforts of the central path, and positively affects the purchasing intention through cognitive response; (3) Emotional arousal variables positively affect emotional response; (4) Perceived cognitive effort positively affect cognitive response. (5) Cognitive and emotional responses positively affect consumers' purchasing intention, among which emotional reaction plays a more dominant role.

In this study, regulatory focus and ELM theory are introduced into the impact of emotional negative online comments on consumer behavior. The main theoretical contributions are reflected in the following aspects: Firstly, the results show that consumers' purchasing decisions are influenced by the way of information processing. Specifically, after browsing emotional

reviews, consumers' emotional tendency turns out to be important factor that affects decision-making and information behavior, and this influence is regulated by consumers' own characteristics (i.e., promotion and prevention focused personality), thus forming the unique information processing methods of different individuals. The research explored the specific internal mechanism of consumer behavior, and changed from the thinking pattern of "phenomenon-result" which is common in relevant experimental research, to the demonstration of "phenomenon-path-result", thus casting light into the black box of consumer behavior in a more profound and detailed manner. Secondly, the existing researcher tend to discuss ELM theory and regulatory focus theory separately when studying consumer attitude change or purchasing intention. The former pays more attention to the information processing mode of consumers, and the latter tends to divide consumers into two different groups according to their personality traits. This paper combines ELM theory with regulatory focus theory, and finds that consumers tend to choose information processing methods that conform to their own personality characteristics after receiving information. When reviews convey emotional content matching the personality characteristics of the target audience, reviews will have a greater impact on consumer attitudes. At the same time, the results of the existing studies in discussing the mechanism of negative reviews and consumer behavior lack generality. Our study focuses on the certain situation of emotional negative reviews, starting from consumer perception to further explore the psychological mechanism of consumer behavior decisions, which also provides a reference for other scholars to explain the differences in consumer behavior decisions.

Practical significance

Firstly, according to the conclusion of hypothesis 3, consumers' cognition and emotional reaction positively affect consumers' purchasing intention. For negative reviews, merchants are supposed reduce negative reactions of consumers and make full use of social media to communicate with consumers. Merchants can avoid or remedy emotional negative reviews such as anger and sadness caused by consumers' dissatisfaction by improving quality of product and service. For the emotional negative reviews that have existed, the merchants should respond to such comments in a punctual manner. During the data analysis, we found that negative emotional reactions are more dominant in the final decision-making of consumers. Therefore, consumers are encouraged to write objective reviews and cut down sentimental words and modal words to avoid negative consumer behaviors.

Secondly, the e-commerce platform can determine the type of consumer according to the collection volume of consumers, the ratio of recent trading volume to time, or ask several related questions during register process, and display the matching reviews based on group division to affect their purchasing intention. According to the conclusion of Hypothesis 4, for the promotion focused consumer groups, merchants and platforms can respond positively to some negative emotional reviews involving questioning cognitive information (product characteristics, quality, etc.). For the prevention focused groups, businesses and platforms can also actively avoid reviews with strong emotional intensity through after-sales service and remedial measures, which is conducive to reducing the adoption and influence of the prevention focused groups on these negative reviews with strong emotional intensity, or weaken their prevention characteristics through the design of the website interface, and try to offset other positive emotional experiences of the prevention focused individuals, such as offering coupons.

Limitation and prospect

Limitation: 1. The experimental object of this research is college students. Although inviting such groups can ignore the technical problems of social media use and the interference of product knowledge factors of experimental objects, the homogeneity limits the representativeness of demographics. 2. This experiment only focused on search products such as mobile phones. When compiling the reviews, we classifies the emotional intensity according to the different emotional words, and only involves the product function problems. In order to control the weight of product attributes in the stimulus information, we are supposed to further verified which of the emotional words and product problems in the negative reviews has a more significant effect on consumer behavior.

Prospect: 1. Future research is encouraged to introduce adjustment matching theory to explore consumers' information preference. 2. it is the future research direction to explore whether there are other regulatory variables in the relationship between attitude and behavior, and whether the consistency of cognitive and emotional responses has different differences for different consumers. 3. Future research can also focus on online reviews with mixed positive and negative emotions, and explore the differences between mixed reviews and changes in consumers' purchasing intention caused by monochromatic reviews.

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The impact of signal of project quality and creator's credibility on crowdfunding performance based on fsQCA method

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ABSTRACT

Crowdfunding is becoming increasingly important for entrepreneurs to raise funds in recent years. Whilst research has shown different influencing factors of crowdfunding performance as signals which can convey information, how signals work together remains underexplored. This study, which is based on a Chinese product crowdfunding platform, uses fsQCA to examine how the signal of project quality (number of likes project received, number of updates, number of description words) and creator's credibility (number of likes creator received, experience as a backer, experience as a creator) influence crowdfunding performance. We crawled 381 samples from MoDian crowdfunding platform. The results identify five configurations for high financing performance and five configurations for low financing performance. Our findings enrich the literature of crowdfunding performance based on signal theory and make practical contributions to project creators.

Keywords: Crowdfunding, Signaling theory, fuzzy-set Qualitative comparative analysis (fsQCA)..

INTRODUCTION

Crowdfunding is defined as fundraisers (or project creators) raising funds from backers through crowdfunding platforms to support personal activities, public welfare projects or business organizations (Ahlers et al., 2015). Because of low financing cost, rich financing platform and high financing efficiency, it is favored by entrepreneurs and provides a new method to solve the financing difficulties for small and micro enterprises. The number of Chinese crowdfunding platforms has decreased sharply since 2016. However, the number of participants and financing amount of crowdfunding projects are increasing year by year. In the first half of 2018, 48935 projects were launched. Among them, the number of successful projects was 40274, and the financing amount of successful projects reached 13.711 billion yuan, an increase of 24.46% over the first half of 2017. The fact is that crowdfunding industries are booming in China with large scale and rapid growth.

This study aims to examine the crowdfunding performance of product crowdfunding platforms. The life cycle of product crowdfunding includes three stages: project preparation, financing and product delivery (Wang et al., 2021). In the stage of project preparation, the project creator needs to determine the project name, description, target amount and duration, etc., so as to show the project quality and the creator's credibility. The challenge is that there exists information asymmetry between creators and backers. On the one hand, unprofessional supporters are unable to accurately assess the potential risks and benefits of the projects and face huge investment risks. On the other hand, creators face the challenge of communicating credible information about project quality and personal capabilities to backers. Therefore, it is crucial to find effective ways to reduce information asymmetry and improve crowdfunding performance.

Although researchers are increasingly focusing on the role of different signals in crowdfunding performance (Reichenbach & Walther, 2021), how various signaling factors interact to determine crowdfunding performance remains limited. The relevant research on the influencing factors of crowdfunding success only regards the signals as simple additive components, ignoring the interactive effects among them. This study explores the impact of different signal combinations on crowdfunding performance by using fsQCA. We crawled 381 cases from the MoDian crowdfunding platform and analyzed the interactions among signals of project quality and the creator's credibility. The results revealed five configurations of high financing performance and five configurations of low financing performance.

Our study contributes to the literature in several aspects. First, we adopt fsQCA to explore the relationship between configurations of different signals and high crowdfunding performance. It shows how to combine the signals of project quality (i.e., number of likes project received, number of updates, number of description words) and creator's credibility (i.e., number of likes creator received, experience as a backer, experience as a creator) into a variety of configurations in different ways to achieve high crowdfunding performance. Second, this study expands research on crowdfunding performance based on signal

theory by setting out four propositions. Third, our findings offer practical implications for project creators on how to leverage different signals to achieve high financing performance.

The rest of this paper is organized as follows. Section 2 reviews relevant literature of information asymmetry in crowdfunding and signaling theory, and section 3 presents the research method. Section 4 reports the empirical findings. Section 5 discusses our findings and set out our propositions. Finally, we outline the contributions, limitations and directions for future research.

THEORETICAL BACKGROUND

Information Asymmetry in Crowdfunding

Information asymmetry occurs when individuals have information that others cannot easily obtain for exchange (Cosh et al., 2005). It is a normal problem for entrepreneurs when financing, which may prevent the formation of exchange relationship. Because insiders usually have more information about the quality of the company than outsiders.

The information asymmetry in the crowdfunding platform will make it difficult for potential investors to identify high-quality project investments. Compared with traditional investments (banks, venture capitalists or angel investors), product crowdfunding investors are usually non-professionals and lack a full understanding of the industry, technology, management and investment. Colombo et al. (2015) found that potential backers' doubts about creators' ability and credibility are one of the main sources of uncertainty in crowdfunding. Backers cannot identify project quality and creators' credibility when investing without proper information.

Signaling Theory

Signals are the activities or attributes of individuals in the market, which can change the beliefs of other individuals and reduce information asymmetry. In crowdfunding, signals can reduce the uncertainty perceived by decision-makers, so as to persuade them to support a project with their investment (O. Colombo, 2021).

Specifically, project creators can send signals related to project quality and creators' credibility, such as project description, pictures, videos and so on. Investors will infer the unobservable quality of their enterprises from the observable attributes, and those projects that fail to provide such information should be evaluated as poor prospects. Researchers also try to identify different signals related to project quality or creators' credibility, which is effective in attracting backers and improving financing performance (Bi et al., 2017).

Signals of project quality

Before the project starts, the project creator needs to make a series of preparations. The signals of project preparation can reflect the efforts of the creator in project design and project quality. Therefore, sufficient preparations are conducted for the project creator to obtain funds from backers. In the design process of crowdfunding projects, project creators can reduce information asymmetry and convince backers by using text, pictures, videos and other signals. Research suggests providing detailed project descriptions can help the project achieve higher financing performance. The integrity of project description can be reflected by the number of words and the richness of contents (Liang et al., 2020).

Project updates play a crucial role in information exchange between project creators and backers. Communicating the progress of the project by project updates can make backers feel trust, excitement and expectation for the project (Usman et al., 2020). In addition, project updates also mean that the project creator has strict control over the project. Therefore, project updates help to reduce the information asymmetry between project creators and backers.

The number of likes project received is the positive feedback of the backers for the project. When making decisions on purchase and investment, social networking platform users largely rely on electronic word-of-mouth such as online comments and the number of likes. Studies show that online product reviews are usually accompanied by signals agreed by reviewers, such as the number of likes, and most respondents believe that the number of likes project received is very important to them when viewing product information (Jiménez & Mendoza, 2013).

Signals of creators' credibility

The experience as a creator enables the project creator to deeply understand the operation of crowdfunding, arrange the resources required by the project, and meet the needs and expectations of backers. Research suggests that project creators with launching experience can show the signals of low project risks and achieve higher financing performance than those without launching experience (Wang et al., 2021b).

The experience as a backer allows project creator to develop a shared identity with other backers on the crowdfunding platform, which can affect the financing performance of crowdfunding. Mutual identification might induce individuals to provide financial support or help promote their projects. Backer experience might allow entrepreneurs to learn good practices that can be adopted in their crowdfunding projects, which leads to mutual help from other project creators. Indeed, empirical evidences suggest that there is a positive correlation between backer experience of project creators and crowdfunding financing performance (J.-Y. Kim & Miner, 2007).

The social network connections of the project creator can convey additional information to potential backers of the project, reduce information asymmetry and improve crowdfunding financing performance (Mollick, 2014). On the crowdfunding platform, the degree of social network connections of the project creator is reflected in the number of fans and likes, which reflects the attention of potential supporters to the project. Close social network connections can enhance creators' credibility, which can attract more potential backers especially their fans to support their projects.

METHOD

Qualitative comparative analysis (QCA) is an empirical analysis method which can be used in small or large sample cases. QCA focus on the combination of conditions related to product crowdfunding performance (high or low). Regression analysis pays attention to the impact of a single variable on the results, when there is multiple collinearity between variables, it may cause error estimation of independent variables. Compared with regression analysis, QCA can explore the mechanism between variables and results, and provide multiple conditional configurations that lead to certain results. In this study, we adopt fuzzy set qualitative comparative analysis (fsQCA), which can calibrate continuous values using values between 0 and 1.

Sample and Data Collection

The data in this study were retrieved from a Chinese product crowdfunding platform named MoDian, which is a representative crowdfunding platform focusing on cultural and creative products. We crawled crowdfunding campaigns data from 2015 to 2021 on this crowdfunding platform. In order to eliminate the impact of different target amounts and ensure the comparability of samples, we chose projects with the target amount of 10000. To keep the integrity of the data and the validity of the cases, the cases with extreme value and default value are removed. Finally, 381 cases remain.

Outcome, Causal Conditions and Calibration

In this study, we adopt the signaling theory as the theoretical perspective to determine the research variables (Chen et al., 2018). According to signaling theory, the framework in this study was constructed with project quality and creators' credibility. The outcome is defined as crowdfunding performance and measured as the ratio between the amount of funds raised in the crowdfunding round and the target amount. To explore the conditions influencing the crowdfunding performance from the existing literature, six conditions were extracted: three refer to the project quality (number of likes project received, number of updates, number of description words), and three relate to the creators' credibility (number of likes creator received, experience as a backer, experience as a creator). The descriptive statistics of the samples are shown in Table I.

Table 1: Descriptive statistics and calibration.

Variables		Description	Mean	S. D	Min	Max
Signals of Project Quality	Crowdfunding Performance (CP)	The ratio between the amount of funds raised in the crowdfunding round and the target amount	3.051	2.243	1.001	10.839
	Project Like (PL)	The number of likes project received	498.496	312.947	86	1624
	Update (UP)	The number of updates	8.255	6.730	0	51
Signals of Creators' Credibility	Project Description (PD)	The number of description words	100.499	20.159	40	159
	Creator Like (CL)	The number of likes creator received	138.000	239.446	0	1063
	Experience as a Backer (CB)	Experience as a backer	5.084	13.914	0	72
	Experience as a Creator (CC)	Experience as a creator	5.743	8.098	1	43

Source: This study.

To use fsQCA, we need to calibrate the original data. Following (Ragin, 2009), the calibration was based on direct method. In this study, the full membership was defined as the 75th percentile, the cross-over point as the 50th percentile, and the full non-membership point was defined by the 25th (De Crescenzo et al., 2020). Table 2 presents the thresholds for the calibration.

Table 2: Calibration for outcomes and causal conditions.

Variables	Full membership	Cross-over point	Full non-membership
Crowdfunding Performance (CP)	3.911	2.248	1.323

Project Like (PL)	658	415	266
Update (UP)	10	7	4
Project Description (PD)	118	106	89
Creator Like (CL)	142	13	2
Experience as a Backer (CB)	3	1	0
Experience as a Creator (CC)	6	2	1

Source: This study.

RESULTS

Analysis of Necessary Conditions

We used fsQCA 3.0 software for analysis. The first step is to examine whether the presence or absence (~) of any factors are necessary to achieve high or low crowdfunding performance. Necessary conditions mean conditions that must occur to achieve the outcome. A condition is considered necessary if the consistency is higher than 0.9 (Greckhamer et al., 2018). As shown in Table 3, there is no necessary condition for the outcome because every consistency score is below the threshold of 0.9.

Table 3: Analysis of necessary conditions.

Causal Condition	High crowdfunding performance		Low crowdfunding performance	
	Consistency	Coverage	Consistency	Coverage
Project Like	0.759	0.768	0.350	0.354
~Project Like	0.362	0.357	0.771	0.763
Update	0.648	0.667	0.414	0.427
~Update	0.443	0.430	0.677	0.659
Project Description	0.540	0.535	0.562	0.559
~Project Description	0.555	0.558	0.532	0.537
Creator Like	0.559	0.593	0.492	0.523
~Creator Like	0.551	0.520	0.617	0.584
Experience as a Backer	0.553	0.607	0.456	0.502
~Experience as a Backer	0.546	0.500	0.643	0.591
Experience as a Creator	0.625	0.598	0.522	0.500
~Experience as a Creator	0.477	0.499	0.580	0.608

Note: The symbol (~) indicates the absence of the condition.

Analysis of Sufficient Conditions

We filtered the truth table by setting relevant thresholds. First, we used a frequency threshold of 1, ensuring that there is at least one representative case for each configuration determined by fsQCA. Secondly, the raw consistency threshold was set to 0.8 which is a recommended standard (Ragin, 2009). Consistency indicates the score of the configuration in the results. Finally, we used a PRI consistency threshold of 0.75 for high crowdfunding performance, and 0.8 for low crowdfunding performance, which are greater than 0.75 (Park et al., 2020).

There are three types of solutions: complex, intermediate and parsimonious solutions. Based on the above simplified truth table for standardized analysis, the three types of solutions were totally the same. Since the number of samples in this study is large, the cases can cover all combinations, and there was no logical remainder included in the standard analysis. The analysis of sufficient conditions yielded two models: one for high crowdfunding performance and one for low crowdfunding performance. The solution consistency of high crowdfunding performance is 0.869 (solution coverage is 0.448), and the solution consistency of low crowdfunding performance is 0.889 (solution coverage is 0.451). Both models are good, with a solution consistency of more than 0.75 and a solution coverage of more than 0.4 (Ragin, 2009).

Table 4 shows the results from sufficiency analysis following the notation introduced in the study of (Courtney et al., 2017): the black circle (●) indicates the existence of the condition, the circle with a cross-out (⊗) indicates the absence of the condition, and the blank indicates that the configuration condition can be either present or absent.

Table 4: Analysis of sufficient conditions.

		High crowdfunding performance					Low crowdfunding performance				
		A1a	A1b	A2a	A2b	A3	B1a	B1b	B2	B3	B4
Signals of project quality	Project Like	●	●	●	●	●	⊗	⊗	⊗	⊗	⊗
	Update	●	●	●	●		⊗	⊗	●	⊗	⊗
	Project Description		⊗	●	●	⊗		⊗		●	●
Signals of creators' credibility	Creator Like	⊗	⊗	⊗	⊗	●		⊗	●		●
	Experience as a Backer		●	⊗		●	⊗	●	⊗	⊗	
	Experience as a Creator	●			●	●	●	⊗	⊗		●
	Raw coverage	0.141	0.106	0.139	0.204	0.205	0.216	0.086	0.093	0.243	0.158
	Unique coverage	0.010	0.021	0.067	0.077	0.110	0.058	0.033	0.042	0.094	0.055
	Consistency	0.895	0.889	0.875	0.877	0.907	0.903	0.911	0.934	0.880	0.912
	Solution coverage	0.448					0.451				
	Solution consistency	0.869					0.889				

Note: The black circle (●) indicates the existence of the condition, the circle with a cross-out (⊗) indicates the absence of the condition, and blank cells indicate that the presence or absence of the condition doesn't matter. These are "don't care" conditions.

Based on the signaling theory, we identified five conditional configurations of high crowdfunding performance and five conditional configurations of low crowdfunding performance respectively.

High crowdfunding performance

Configuration A1a (consistency: 0.895, coverage: 0.141) shows that when the project creator receives fewer likes, but the project creator has rich experience in launching, and the project receives more praise and project updates, the project financing performance will be higher. Configuration A1b (consistency: 0.889, coverage: 0.106) implies that when the creator has rich experience as a backer, and the number of likes and updates of the project are high, even if the number of project description words and likes creator received are less, the crowdfunding performance is also high. Comparing configuration A1a with configuration A1b, both conditional configurations have a high number of likes project received and updates, and the signals of the creators' credibility are different. The results show that the experience as a backer and experience as a creator are substitutable factors.

Proposition 1: To achieve high crowdfunding performance in a project with a high number of project likes and updates, signals of experience as a backer and experience as a creator are substitutable factors.

Configuration A2a (consistency: 0.875, coverage: 0.139) indicates that when the creator receives a low number of likes and does not have a rich experience as a backer, if the project possesses a high number of likes, updates and description words, it can achieve high financing performance.

Compared with configuration A2a, configuration A2b (consistency: 0.877, coverage: 0.204) has one more condition that is the project creator has rich experience as a creator, which can also produce high financing performance. Previous studies have shown that the signals of crowdfunding experience and project quality are crucial to the success of crowdfunding (Courtney et al., 2017). Comparing configuration A2a with configuration A2b, we found that when the signals of project quality are sufficient, even without the reputation signals of the project sponsor, it still produces high financing performance. More project information implies higher project quality signals, so potential supporters' distrust of project sponsors who lack crowdfunding experience will also be reduced. Since there exists cost in the signal transmission process, it may be too expensive for entrepreneurs to take advantage of both creators' credibility and project quality signals. Similarly, the signals of project quality can make up for the signals of creators' credibility. Therefore, we propose the following proposition:

Proposition 2: When the signals of project quality are sufficient (high number of project likes, updates, description words), even if there are no signals of creators' credibility, it can also achieve high crowdfunding performance.

Configuration A3 (consistency: 0.907, coverage: 0.205) shows that when the project is launched by a creator with rich crowdfunding experience (experience as a backer and creator), if both the creator and the project obtain a high number of likes, it can achieve high crowdfunding performance without more project description.

Low crowdfunding performance

Configuration B1a (consistency: 0.903, coverage: 0.216) and configuration B1b (consistency: 0.911, coverage: 0.086) indicate that when the project is launched by a creator with crowdfunding experience as a backer or creator, it cannot produce high crowdfunding financing performance with a low number of project likes, updates, and description words. Comparing configuration B1 (B1a and B1b) and configuration A1 (A1a and A1b) which achieve high financing performance, A1 have the signals of project quality (high number of project likes and updates). Due to the information asymmetry in crowdfunding, entrepreneurs usually need to show the project's potential through observable signals to reduce the perceived risk of potential backers (Davies & Giovannetti, 2018). The results highlight the importance of the signals of project quality. Therefore, we propose the following:

Proposition 3: The signals of creators' credibility are not sufficient to produce high crowdfunding performance without any signals of project quality.

Configurations B2, B3 and B4 are other configurations of low crowdfunding performance that cannot be classified. Configuration B2 implies that a high number of project updates and likes creator received cannot produce high financing performance when other signals are absent. Configuration B3 suggests that the absence of all signals except a high number of project description words can lead to low financing performance. Configuration B4 shows that the joint presence of creator experience, the high number of project description words and likes creator received are not sufficient to produce high crowdfunding performance when project likes and updates are absent.

Asymmetry in configurations of high and low crowdfunding performance

The causal asymmetry of QCA means that the reasons for the presence (such as high performance) and absence (such as low performance) of the expected results are different, which need to be analyzed separately. According to the causal asymmetry, even if it can be concluded that the presence of a certain condition will lead to high performance, it cannot be inferred that the absence of this condition will lead to low performance. This assumption can explain the differences between cases and the configuration effect of interdependence among conditions. These results show that the condition configurations of high financing performance and low financing performance are not symmetrical. Therefore, we propose the following proposition:

Proposition 4: The structures of configurations for high crowdfunding performance and those for low crowdfunding performance are asymmetric.

Robustness Checks

To scrutinize the results, we performed a series of robustness checks by changing the case frequency (from 1 to 2) and changing the PRI consistency thresholds (increased by 0.1). The consistency and coverage of the overall solutions were the same as the original results. And the configurations identified from the robustness test did not change.

RESULTS

This study examines conditions that affect the crowdfunding financing performance (i.e., number of likes project received, number of updates, number of description words, number of likes creator received, experience as a backer, and experience as a creator). Table 5 shows the four propositions concluded in this study. Overall, our results suggest that the signals of project quality and creator's credibility play an important role in crowdfunding performance.

Table 5: Propositions concluded in this study.

	Proposition
Proposition 1	To achieve high crowdfunding performance in a project with high number of project likes and updates, signals of experience as a backer and experience as a creator are substitutable factors.
Proposition 2	When the signals of project quality are sufficient (high number of project likes, updates, description words), even if there are no signals of creators' credibility, it can also achieve high crowdfunding performance.
Proposition 3	The signals of creators' credibility are not sufficient to produce high crowdfunding performance without any signals of project quality.
Proposition 4	The structures of configurations for high crowdfunding performance and those for low crowdfunding performance are asymmetric.

Source: This study.

For project creators, the crowdfunding experience represents the creator's ability to successfully launch the project and increases financing performance (Borrero-Domínguez et al., 2020). On online crowdfunding platforms, when entrepreneur launches crowdfunding projects or support others' projects, they can develop the necessary knowledge and skills over time, which can indicate the credibility of the project creator. Proposition 1 suggests that the project creator's initiation experience and supporting experience are substitutes for each other in demonstrating their credibility. Entrepreneurs with experience in project initiation tend to have broader social capital, who are able to work with a wide range of stakeholders and have a competitive advantage over novices in accessing resources. Entrepreneurs with supporting experience can learn from others' projects about launching crowdfunding projects, such as writing project descriptions, developing marketing plans, communicating with clients, etc.

Our findings also show that crowdfunding investors are rational when it comes to investments. Propositions 2 and 3 indicate that investors will be more cautious than we originally thought in interpreting project quality signals and project creators' credibility signals. Previous research has suggested that creators' credibility signals may offset the lack of project quality signals (Huang et al., 2022a). However, our findings uncover that the creator's credibility does not compensate for the lack of project quality. Configurations B1a and B1b, for example, all entail the signal of creator's credibility but no signal of project quality, which both have a low financing performance. We extend previous research by revealing the interaction between project quality signals and project creators' credibility signals in influencing crowdfunding performance. Our results also support the idea that the effectiveness of one signal depends on the presence of the other (Huang et al., 2022b). More importantly, we demonstrate that the lack of project creator's credibility signal does not necessarily hinder crowdfunding success, as it can be offset by the presence of project quality. Our findings also show that achieving high crowdfunding performance depends on the configuration of various signals.

Our study reveals the causal complexity between project disclosure and crowdfunding performance. Since signals can be significant in certain specific contexts, the configurations of low-level outcomes are not necessarily the opposite of those of high-level outcomes. That means with appropriate configurations, low-level signals may also produce positive outcomes. The asymmetry between configurations of high and low crowdfunding performance offers the possibility for projects to maintain a balance between information disclosure and privacy protection.

CONCLUSION

In recent years, an increasing number of entrepreneurs have resorted to crowdfunding to obtain financing. However, there is a great deal of information asymmetry in crowdfunding platforms, and entrepreneurs often need to rely on observable signals to demonstrate the potential of their projects. Based on signaling theory, this study reveals how signals of project quality and creator's credibility work together to generate high crowdfunding performance. We demonstrate that the effectiveness of crowdfunding signals depends on their configuration.

Implications for Research

This study expands the research on crowdfunding performance based on the signaling theory, and further examines the impact of project quality signals and creator's credibility signals on crowdfunding performance, enriching the understanding of effective signals.

Previous studies have focused more on the role of a single signal through asymmetric approach (K. Kim & Viswanathan, 2018). This study examines how the interaction of multiple signals influences crowdfunding performance by using the fsQCA approach. The role of an entrepreneur's credibility and project quality on crowdfunding success has been explored. However, most considered linear influence relationships from a single signal, and the potential interactions and causal complexity between different signals are often overlooked.

This study has not only identified multiple configurations that can produce the same outcome but also summarize them into four propositions that explain the complex phenomenon of crowdfunding success in a more meaningful way. By comparing the condition configuration of high crowdfunding performance and low crowdfunding performance, we find that the configurations of high crowdfunding performance are not the complete opposite of low crowdfunding performance. This shows that the condition configurations of high crowdfunding performance and low crowdfunding performance are independent of each other and related to different combinations of signals.

Implications for Practice

This study also provides practical implications for the project creators on how to leverage different signals for obtaining high crowdfunding performance in product crowdfunding.

Firstly, with the absence of signals of creators' credibility (creator experience and backer experience), the project creator can pay more attention on project preparation to highlight the signals of project quality such as likes received by the project, project updates and description words, so as to reduce information asymmetry and gain the trust of potential supporters.

Secondly, when the project creator does not have experience as a creator, he can accumulate backer experience by supporting others' projects. On the one hand, he can learn how to design crowdfunding projects from others' projects. On the other hand,

he can also convey the signals of creators' credibility to potential supporters. Thirdly, when the project is launched by a creator with rich crowdfunding experience and close social network connections, it cannot fully persuade potential supporters to invest. They also need to obtain signals of project quality, so as to make investment decisions. Therefore, when launching a crowdfunding project, the project creator needs to carefully consider the signals of project quality and creators' credibility.

Limitations and Future Research

This study has the following limitations. Firstly, this study only captures data from MoDian crowdfunding platform. Due to different levels of uncertainty among different crowdfunding platforms, the results of this crowdfunding platform might not be generalizable to other product crowdfunding platforms. Future research can test the impacts of different configurations of signals in other types of product crowdfunding platforms (e.g., electronic appliances or commodities). Secondly, this study is based on objective data publicly available on the platforms. There are other conditions which are related to project quality and creators' credibility, such as the number of videos, pictures, social software friends and so on. Therefore, more relevant data are required to assess the influence of signals.

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The influence of online Danmu on users' reward behavior: Based on the data of Douyu live broadcast

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ABSTRACT

In live streaming, the Danmu is a crucial technique of interaction, and the reward is the interaction's feedback. The audience receives more input through the reward the more frequently they interact. The effect of the bullet screen in the live broadcast on the audience's reward behavior was investigated by gathering data from the live broadcast room 5720533 on Douyu, a domestic Danmu live-streaming website, from February 14 to February 24, 2021. Based on empirical research, the following conclusions can be drawn: the number of user Danmu, the proportion of fan Danmu, the number of user entry Danmu, and the number of super Danmu will all significantly improve users' reward, while personal experience attenuates the positive impact of the number of user access Danmu and the number of super Danmu on the impact of user reward. The study's findings will offer theoretical justification for the creation of live broadcast platforms, the upkeep of anchors' notoriety, and users' rational consumption.

Keywords: Danmu; Reward; Interaction ritual chain theory; Signal theory; Personal experience.

INTRODUCTION

Live streaming is extremely popular because they give the audience a more immersive, interactive, and real-time sensation when compared to other media. Due to its powerful sense of presence, it serves as a crucial form of entertainment that allows individuals to escape local limitations and unwind during an epidemic. Reward and barrage are the features that consumers interact with and use the most frequently in live broadcasts. Consider the Douyu website as an illustration. Within four weeks, 1.08 million audiences awarded the anchor, 420000 of whom selected to reward high-value presents. More than 7 million users sent a barrage while watching the live show (Wang et al., 2018).

Both Danmu and reward have been around on the Internet for a short period of time, and both have evolved from one field to the other, being accepted and used in a wider range of contexts. Reward emerged from online literary websites and gained further use on social media, but received more attention still after the emergence of live streaming as the main method of profit and interaction. In live streaming, the factors that stimulate audience to reward include the emotional factors of the rewarder and the environment of the live streaming room. The audience will reward the supporting anchor since they enjoy the live broadcast content. The reward can simultaneously catch the anchor's eye and satisfy the audience's appetite for interactive content (Lu et al., 2018). Researchers argue that in addition to the interaction between the anchor and the audience that can influence the reward of the user, the interaction between the audience and the audience can also promote reward by influencing audience' excitement levels (Zhou et al., 2019). In addition, the social relationship between the anchor and the audience is also an influencing factor, as the anchor uses terms such as "boss" to the audience, which makes the user feel a higher social status (Lee et al., 2018). Live streaming is inseparable from the support of Danmu, which is an integral part of them and drives the development of live streaming (Yao, 2019). Studies have found that Danmu features have a significant impact on user behavior (Wang, 2022), and that audience will even pay more attention to Danmu than to video content (Wan, Moscowitz & Wu, 2020). Compared to other forms of interaction, Danmu contains richer information from which researchers can gain insight into the audience's emotional tendencies and thus user preferences (Chen, Chen & Pan, 2021), and researchers are beginning to experiment with evaluating and regulating live streaming through Danmu content (Zhao et al., 2018).

Danmu has not been around for long, and the main application scenarios and studies have focused on video, with relatively little research on Danmu in live streaming. Although there have been studies of user reward in live streaming, researchers have mostly looked at the virtual community relationship established by the anchor and the live stream, and less at the role of situational factors brought about by other features in live streaming. The study collected a large amount of secondary data on Danmu and reward from the Douyu live-streaming platform and analyzed the mechanism of the influence of Danmu features on audiences' reward behavior in the live-streaming scenario and whether the influence of Danmu differs for user with different levels of experience with the live-streaming platform. The user is the audience of the live room in the study. The study not only enriches the research on Danmu and user reward in live streaming scenarios but also provides theoretical support for the development of live streaming platforms, the maintenance of anchors' enthusiasm, and the rational consumption of users.

HYPOTHESES AND RESEARCH MODELS

Theoretical Basis

American sociologist Collins created the interaction ritual chain theory as a sociological explanation for human behavior. According to him, all human interactions take place in certain contexts where participants will develop a shared focus of attention, experience each other's emotions, and create a shared emotional experience. Live webcasting satisfies the requirements of the interaction ritual chain, which include shared presence, openness to outsiders, shared concentration, and shared emotional experience (Wang & Li, 2020).

In live streaming, audiences enter the live room via their live broadcasting platform accounts and coexist there with the anchor under the guise of an anonymous ID. The engagement, such as the Danmu, in the live room is inaccessible to those without an account or who have not joined; this satisfies the requirements of restricting access to outsiders. When an audience member enters the live room with a particular interest, the entire audience engages in a series of interactive activities that are all focused on the anchor's live broadcast content, giving them a shared interest. Due to the live room's content, the environment in the live room, and other people's emotional disclosures, the audience will experience emotional swings. Through Danmu and rewards, they will express their feelings. After hearing this emotional sharing, the anchor and other audiences will respond to gauge the audience's reaction. The emotional energy will increase as the audience shares an emotional experience, which will encourage the audience to talk more about and express their emotions with others while paying close attention. This will ultimately lead to a sense of excitement among the audience members.

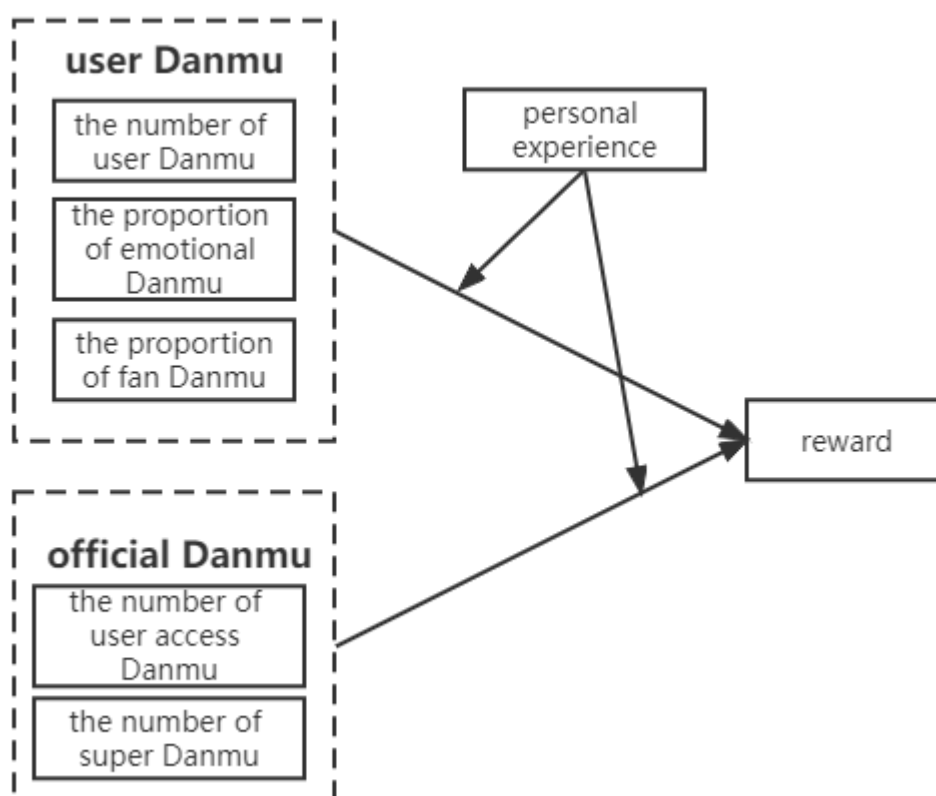
Four outcomes are reached by involvement in the interaction ritual chain: group togetherness; individual emotional energy; represents the symbol and moral sense of the collective. The study will not be mentioned because the Danmu does not reflect moral sense. Due to the content of the live room and the information on the Danmu, the audience will experience emotions like joy and rage while viewing it. They will communicate with other audiences by transmitting Danmu, and when other audiences read and respond to the information on the Danmu, this emotion will become stronger and accumulate emotional energy. Additionally, more audiences who engage in conversation are eligible to get the fan medal, which serves as the group's emblem. The involvement of fans will hasten the accumulation of emotions. Reward communicates more powerful emotions as compared to the Danmu. Since there is no such thing as a body in space, rewards have a significant role in how emotions are expressed after achieving a peak. The richer the emotions it contains, the more fans it engages, and the greater the likelihood of its reward action, the more the barrage.

When studying the labor market in the 1970s, American economist Spence proposed the signal theory, which was primarily used to analyze information asymmetry. According to Spence (Spence, 1978), there is an information gap between employers and employees in the labor market, meaning that businesses are unaware of the skills of their employees. In this instance, employees take some expensive activities as signals to indicate that they are more talented in specific areas than other employees in order to stand out from the competition. Employers can assess employees' abilities and make hiring decisions based on these signals. On the back of Spence, the signal theory was later created. The information sender, the signal, the information receiver, the feedback, and the signal environment currently make up the entire theoretical framework. The signal theory states that in the case of asymmetric information, on the one hand, the information lacking party will actively seek useful signals to aid in speculation and judgment of the true situation of goods or services, and on the other hand, the information dominating party will deliberately send out signals to assist the information weak party in differentiating itself from other rivals, understanding its actual situation, and avoiding making decisions based on incomplete information.

The audience can clearly observe the anchor's live room during the live webcast because of the assistance of technology. The audience can only comprehend the live content of the present anchor's performance, however, because of the virtual nature of the network and the separation between them. The prior data, the emotions of other audiences, the live interactive activities, the fan system, and the expected value they can derive from the reward are all unknowns. The audience and the entire live streaming are in an asymmetrical information situation, thus it is important to use other factors to lessen the public's confusion about the live room. The Danmu is divided into the Danmu published by the audience and published by the system. The system publishes Danmu with information about the live room, and the user publishes Danmu with their judgment of the content of the live room. Therefore, the Danmu can transmit information about the content and quality of the live room, eliminate the uncertainty of the audience, help users judge the real situation of the live room, distinguish the live room from other live rooms, and promote the reward behavior of the audience in the live room. Different audiences have different past experience and different grasp of initial information, so personal experience will play a regulating role in the user's judgment through the bullet screen information.

Structural Model

A model was developed based on the interaction ritual chain and signal theory to show how the user Danmu characteristics and the official Danmu characteristics affected the reward. Personal experience also played a regulatory role. The study's structural model is shown in Figure 1.



Source: This Study
Figure 1: Structural Model

Theoretical Hypothesis

User Danmu is the audience's opinions and emotions presented on the live streaming in the form of text based on the live content and their own experience while watching the host in the live room. In the interaction ritual chain, the emotional energy accumulated through interaction will make participants continue to give, and the cost of giving will deepen (Zhang, 2021). In the interaction ritual chain of live streaming, the audience can share their emotions through interactive activities such as sending Danmu and rewarding, and feedback from others reinforces the focus of attention and shared emotional states, making the interaction deeper and more circular. As a result, user-sent Danmu, as a form of interaction, will facilitate interactive feedback from others and promote the generation of user rewards. On the other hand, user Danmu, as third-party comments not directly provided by the live studio, contain very rich information and have high reference value, which can help the audience make judgments about the real situation in the live room, reduce information uncertainty and increase the likelihood of user bounty.

The only way to communicate between users and hosts and between users in live streaming is through user Danmu, so the number of user Danmu can objectively reflect the interaction in the live streaming. Audiences in a live webcast participate in the process of the broadcast by sending in their own Danmu to inform the host and other users of what they are thinking, enabling them to share their emotions and experiences with the group. The higher the number of Danmu, the more users are involved in sharing emotions, feedback on the interaction is facilitated and the user's emotions become more intense. The greater the number of Danmu, the greater the emotional energy of the user, which in turn promotes the generation of bounties. On the other hand, based on signal theory, there is also information asymmetry in the live room. As the information-weak party, the audience will collect all the information in the live room, and Danmu can explain and supplement the video content (He et al., 2017). The more Danmu there is the more information about the live room available to the audience, which will greatly reduce the uncertainty and perceived risk to the audience. More Danmu will increase the audience's attention and trust in the live room, and the audience's willingness to reward will increase. Based on the above analysis, the study proposes the following hypotheses.

H1: The number of user Danmu has a positive effect on users' reward.

User Danmu is a way for the audience to communicate their feelings about watching a live broadcast through the screen, and will generally contain many emotionally charged words that are a reflection of the audience's emotions and reflect their preferences. In the process of watching a live room, the audience will have various emotions due to the focus of their attention. They will send Danmu to express their own emotions, and will also watch others' Danmu to share others' emotions. This type of interaction through emotionally charged Danmu helps to enhance feedback and brings about stronger emotional energy, which in turn promotes reward generation. Research has shown that the emotion of Danmu can have a positive impact on the

emotions of audiences (Zhang, Qiao & Wang, 2021). For audiences, emotionally-charged Danmu is more authentic and credible than commentary-only Danmu, and they are more likely to be adopted. The more emotionally charged Danmu there are, the more emotional information is obtained, and the more useful information audience can obtain from these emotional messages, thus increasing the likelihood of reward. Based on the above analysis, the study proposes the following hypothesis.

H2: The proportion of emotional Danmu has a positive impact on user reward.

User Danmu not only shows the content, but also shows the identity characteristics of the sender of the Danmu to the audience, especially their fan medal rank. After a viewer has made a reward in the live room, he or she will receive a unique fan medal designed by the anchor, and as the number of rewards increases, the user's fan medal level will also increase. Audiences with a fan medal have more attention to the live stream and have a greater influence in the live stream. Fan medals are the result of an interactive ritual, a symbol that represents the membership of the group, making the audience feel relevant to the collective and continuing the emotional experience gained from the interaction (ELGÜN, 2020). When a user with a fan badge sends a Danmu, their fan badge and rank will be displayed in front of the Danmu as proof of their identity. By rewarding them at this point, the audience can stand out from their fans and attract the attention of the anchor, while rewarding them can increase their fan badge rank and expand their influence in the live room. Therefore, when the proportion of Danmu with fan medals is higher, the audience who rewards can obtain higher perceived benefits. Based on the above analysis, the study proposes the following hypothesis.

H3: The proportion of fan Danmu has a positive effect on users' reward.

Official Danmu are a special type of Danmu in live streaming, they are not issued by users, but are presented by the system to all users through Danmu to show some unique information. There are two main types of system-issued Danmu, those that announce the user's entry and those that announce super Danmu from other rooms with bounty messages. The system-published Danmu are official signals from inside the live room, containing information about the number of audience in the room, the reward of other audience, and showing users the real situation in the room. These signals are relatively simple and easy to understand, and audiences are not cost too much to process and are easily influenced by this line of information to make a reward.

User entry Danmu are unique effects and language formatted to show everyone in the live room that the user has entered the live room to watch the show. In cases where the number of audience in the live room is unclear, the entry message from the audience in the official Danmu makes the user aware that many people are watching with them at the same time, perceiving the number of audience in the live room at this time and enhancing the audience's trust in the live room. The more incoming messages the system, the more audience perceives the number of current audiences, the more visibility and popularity they perceive the live room to have, and the higher the perceived value of the live room (He et al., 2016). The pursuit of social value is an important factor in the audience's reward, and when the audience presumes a high audience through user entry Danmu, the reward is likely to occur in pursuit of higher social value. Making bounties at this time can distinguish oneself from others, present oneself in front of the host and incoming users, expand one's influence and achieve a higher social status. Based on the above analysis, the study proposes the following hypothesis.

H4: The number of user entry Danmu has a positive impact on users' reward.

Another official Danmu message of reward information from other rooms, which will remind users that other users are watching other live rooms and have made a reward, is called a super Danmu. reward from other rooms provides an opportunity to exchange information and make the live room more authentic. In 2014, Cheung used signaling theory to demonstrate that both signals - other consumer purchases and consumer comments in online communities - have an impact on consumer purchase decisions. And the influence of other people's buying behavior information is more significant (Cheung et al., 2014). Super Danmu showcased the reward of other users in the live streaming platform, which had a facilitating effect on the reward of users who received the signal. Based on the above analysis, the study proposes the following hypotheses.

H5: The number of super Danmu has a positive effect on users' reward.

The personal experience of the audience in live streaming refers to the awareness generated by the audience in the process of using the site to watch live streaming and participate in the activities therein. The more live streaming audience watches, the more they participate in the activities in the live room, the more they understand and are familiar with the live website and the activities, and the more online experience they will accumulate. In a virtual consumer community, consumers with extensive experience are more likely to choose to pass on and exchange information with other members. In other words, in a live room, consumers with extensive personal experience will be more inclined to actively post and watch user Danmu and exchange information about the broadcast with other audiences through user Danmu, rather than passively accepting information delivered by system Danmu. When the audience is unaware of the live stream and has less information about reward, they are unsure of the emotional benefits and social value that reward can bring them, and may forgo rewarding to avoid losses from not receiving the benefits they want after rewarding, which is a deep-seated tendency to avoid risk. Perceived risk is therefore a disincentive to the audience's reward. Past experience helps the audience to grow in governance and improve their skills (Lee

et al., 2012), and also makes them more receptive to risky information. Experience has an impact on perceptions (Fang Fang et al., 2017), and users with extensive experience with live streaming platforms, with little emotional knowledge of what is going on in the live room, have an unclear perception of their reward benefits but are still willing to reward. Audiences are in a situation of information asymmetry before they collect and process various signals from the live streaming room to improve their understanding of the information and to assist as well as make decisions on reward. As the audience accumulates more personal experience, the higher his level of information mastery, the lower his reliance on signals, and the higher the likelihood of making independent bounty judgments. The information about live rooms and viewers revealed by the number of user entry Danmu and the number of super Danmu is not sensitive to audiences with more experience in live rooms. They do not require the aid of further information because they already have opinions about live rooms. As a result, the number of user entry Danmu and the number of super Danmu will have less of a beneficial effect on users' prizes. Based on the above analysis, the study proposes the following hypotheses.

H6: Personal experience attenuates the positive effect of the number of user entry Danmu on user reward.

H7: Personal experience attenuates the positive effect of the number of super Danmu on user reward.

RESEARCH DESIGN

Data Sources

The data used for the study were sourced from real data generated on one of the largest live streaming platforms in China, Douyu. Python is used in the study to implement the data collection method. The list of all live rooms and pertinent details like room number and heat can be easily obtained through the URL where the live room information is posted. Then, it can instantly retrieve all of the Danmu information from the live room data. Finally, the MySQL database is used to store the collected data. The live room 5720533 appeared the most frequently in the top 20 most popular live rooms, as determined by the heat of the live broadcasting room crawling every hour. On the one hand, the live room's top-20 appearances are correlated with the frequency of its launches. There will be a lot of live data because the overall live time during the data crawling time is substantial. On the other hand, it demonstrates the high level of popularity of the live room, which has a sizable user base and rich Danmu and rewards data. Based on this, the data from the live room of 5720533 were chosen for the following study. From February 9 to February 25, 2021, 314967 Danmu and reward data were gathered in the live room. 3168 data points were produced after the study combined the data and used a sample of the five-minute data. After eliminating the part lacking Danmu data, 1090 samples were eventually obtained.

Index Construction

The dependent variable of this study is the reward behavior of the audience. The quantity of prizes most accurately depicts the audience's reward behavior when participating in the live room, and the study takes the number of rewards given by users within 5 minutes as the measurement data of the dependent variable.

Here are the independent variables:

1. **User_Danmu.** User_Danmu is the term used to describe the onslaught sent by the user when viewing live streaming. The user Danmu's fundamental component is its number. More audiences engage in the conversation of the live room as there are more users of Danmu. The study used the total number of bullets sent within 5 minutes by all users as a measure of this variable.
2. **Emotional_proportion.** Danmu allows people to communicate their actual emotions during live streaming, which can improve interactive feedback. The interactive effect is enhanced and users can learn more information when there is a bigger percentage of Danmu that contains emotions. The effects of Danmu emotions on users' reward behavior are therefore investigated through research and measurement. The study took five minutes to assess the emotional content of every user's Danmu, and the analysis concluded that the ratio of non-neutral Danmu to total user Danmu served as a measure of the emotional content of Danmu. The formula for calculating the Emotional_ proportion is (1), where Emotional_Danmu is the number of user screens with nonneutral emotional polarity, and User_Danmu is the total number of user Danmu.

$$\text{Emotional_proportion} = \text{Emotional_Danmu} / \text{User_Danmu} \quad (1)$$

3. **Fans_proportion.** The sender's identification features will be carried by the user's Danmu while live streaming. The anchor created a special fan medal for each live room. A person who has a fan medal has proven to be a valuable contributor to the live room. The fan medal in the study live room was identified as the name "bang Sa" of the anchor after thorough inquiry. As a result, the study counted the amount of Danmu that contained a fan medal and were sent within five minutes. An indication of the percentage of fans of Danmu is the ratio of this figure to the total number of users. The formula for calculating the Fans_proportion is (2), where Fans_Danmu is the number of user Danmu with fan medals, and User_Danmu is the total number of user Danmu.

$$\text{Fans_proportion} = \text{Fans_Danmu} / \text{User_Danmu} \quad (2)$$

4. Enter_Danmu. One of the independent variables of the study will also include the information that users enter the live room, which is disseminated to users in the live room by a different Danmu. The study used the number of users Danmu the system alerted the user to during the first five minutes as a measure of this variable.
5. Super_Danmu. When a user rewards a significant number of presents in one particular live room, the system broadcasts the reward behavior via a super Danmu to all other live rooms. As a measure of this variable, the study counted how many super Danmu the system alerted participants about within the first five minutes.

The unique experiences of the audiences of the live streaming are the moderating factor in the study. Numerous online groups currently rank members' network experiences based on member level, etc. Similar to this, on the live streaming platform, the more users who watch live streaming and engage in live room activities, the higher the user level and the richer the experience linked to live streaming that users gather from actual activities would be. The research uses the average rating of the reward user in 5 minutes as an indicator of the individual experience of the reward audience.

All of the study's structural indicators are displayed in Table 1.

Table 1: Explanatory Notes for the Study Index

Variable	index	Description
dependent variable	Reward	Number of user rewards
independent variable	User_Danmu	Number of Danmu sent by the user
	Emotional_proportion	The proportion of nonneutral emotions in user's emotional analysis
	Fans_proportion	The proportion of user screens with fan medals
	Enter_Danmu	The number of incoming Danmu reported by the system
	Super_Danmu	Number of super bullet screens reported by the system
moderator	Ruser_grade	The average level of reward users

Source: This Study

DATA ANALYSIS

Descriptive statistics

Table 2 displays the outcomes of descriptive statistical analysis performed on the complete set of data.

Table 2: Descriptive Statistical Analysis

	N (number of effective cases)	minimum	maximum	mean	Standard Deviation
User_Danmu	1090	11	5270	288.96	329.974
Emotional_proportion	1090	0.1766169	1.0000000	0.7639645	0.1502550
Fans_proportion	1090	0.0163934	0.8363636	0.2210674	0.1457022
Enter_Danmu	1090	0	22	6.47	3.926
Super_Danmu	1090	0	29	3.73	3.829
Ruser_grade	1090	0	51	15.8275648	5.0994678
Reward	1090	0	1179	84.97	108.931

Source: This Study

From the table, it can be seen that both users sending Danmu and rewards were more frequent within 5 minutes. Among the users who reward, the average level was 16 and the highest was 51, indicating that there is a certain level difference among bounty users. The proportion of Danmu containing users' emotions varies greatly, and although not all users express their emotions through Danmu, the act of sharing emotions through Danmu is still very frequent. The proportion of users with fan medals, although smaller, is present throughout the broadcast, and some moments are still part of the fan frenzy. For official Danmu, the average number of Danmu entered by users is 6 per 5 minutes and can reach a maximum of 22, there may be cases where part of the users have turned off the notification of their entry into the live room. The average number of super Danmu is 3 per 5 minutes, but can reach a maximum of 29, suggesting that large amounts of reward are not uncommon and that spikes in bounties can sometimes occur.

As can be seen from Table 2, the independent variable, dependent variable, and moderator values fluctuate more and are more discrete. To reduce the impact of large differences in the order of magnitude between variable values, the study transformed all variables logarithmically before conducting the subsequent analysis.

Correlation analysis

The outcomes of the Pearson correlation analysis among all variables are displayed in Table 3.

Table 3: Correlation Analysis

Variable	User_Danmu	Emotional_proportion	Fans_proportion	Enter_Danmu	Super_Danmu	Ruser_grade	Reward
User_Danmu	1						

Emotional_proportion	-0.396**	1					
Fans_proportion	-0.442**	0.478**	1				
Enter_Danmu	0.404**	-0.232**	-0.395**	1			
Super_Danmu	0.399**	-0.237**	-0.320**	-0.339**	1		
Ruser_grade	-0.090**	-0.092**	-0.129**	0.139**	-0.081**	1	
Reward	0.536**	-0.256**	-0.244**	0.325**	0.350**	-0.374**	1

Note: significance level: *** 1%, ** 5%

Source: This Study

According to the analysis, it can be seen that the correlations between all the independent and moderating variables and the dependent variable are, in descending order, User_Danmu, Ruser_grade, Super_Danmu, Enter_Danmu, Emotional_proportion, and Fans_proportion. Since the presence of large correlation coefficients between the independent variables does not rule out the possibility of multicollinearity, the next step of the study will be to test the variables for multicollinearity.

The multicollinearity is tested using variance expansion factors (VIF). The variance expansion coefficient test findings are shown in Table 4 for the User_Danmu, Emotional_proportion, Fans_proportion, Enter_Danmu, Super_Danmu, and Ruser_grade.

Table 4: Multicollinearity Diagnosis

Variable	VIF
User_Danmu	1.508
Emotional_proportion	1.375
Fans_proportion	1.556
Enter_Danmu	1.335
Super_Danmu	1.268
Ruser_grade	1.028

Source: This Study

From the results of the multicollinearity diagnosis, Table 4 shows that the maximum variance inflation factor (VIF) of each variable is only 1.556, which is much smaller than 10. It can be determined that there is no serious multicollinearity among the variables, and the study can use these variables for regression analysis.

Regression analysis

The study will use multiple regression analysis to explore the causal relationship between the dependent variable and independent variable. Based on this, the regression model (3) constructed by the study

$$\begin{aligned} \ln(\text{Reward}) = & \beta_0 + \beta_1 \ln(\text{User_danmu}) + \beta_2 \ln(\text{Emotional_proportion}) + \beta_3 \ln(\text{Fans_proportion}) \\ & + \beta_4 \ln(\text{Enter_danmu}) + \beta_5 \ln(\text{Super_danmu}) + \varepsilon \end{aligned} \quad (3)$$

The study standardized all variables due to the difference in magnitude between the variables. The results of the regression analysis are shown in Table 5.

Table 5: Results of the Regression Analysis of the Effect of Independent Variables on the Number of Bounties

Variable	Unstandardized regression coefficient		Standardized regression coefficient	t	Sig.
	B	S.E.	Beta		
Constant	3.610E-15	0.025		0.000	1.000
User_Danmu	0.441	0.031	0.441	14.352	0.000
Emotional_proportion	-0.053	0.029	-0.053	-1.800	0.072
Fans_proportion	0.066	0.031	0.066	2.133	0.033
Enter_Danmu	0.112	0.029	0.112	3.873	0.000
Super_Danmu	0.145	0.028	0.145	5.136	0.000
F	F=102.265, P=0.000				
R2	0.321				
Adjusted R2	0.317				

Source: This Study

From Table 5, model (3) passed the F-test ($F=102.265$, $p=0.000<0.01$) and the adjusted R² of the model was 0.317, which indicates that these characteristics of the Danmu can influence the reward, but the influence is limited, and other factors also play a role in the user's reward.

The regression coefficient estimates for each independent variable in the regression model and the results of the t-test on the regression coefficients show that User_Danmu, Fans_proportion, Enter_Danmu, and Super_Danmu have a significant positive effect on reward, and H1, H3, H4, and H5 pass the test. The regression coefficient of Emotional_proportion is -0.053 ($t=-1.800$, $p=0.072>0.05$), which does not pass the significance test, indicating that the proportion of emotional Danmu does not have a significant effect on reward, and H2 is not supported.

The method used to verify the moderating effect of reward user rating was hierarchical regression analysis, i.e. adding a moderating term to a model with only independent and moderating variables, comparing the differences in variance explained by different models, and testing whether the effect on the dependent variable was significant to verify the existence of the moderating effect. By using the hierarchical regression technique, the adjustment variable is added to the model (3) to create the model (4). To create models (5) and (6), the dependent variable's interaction terms with the adjustment variable are combined:

$$\begin{aligned} \ln(\text{Reward}) = & \beta_0 + \beta_1 \ln(\text{User_danmu}) + \beta_2 \ln(\text{Emotional_proportion}) + \beta_3 \ln(\text{Fans_proportion}) \\ & + \beta_4 \ln(\text{Enter_danmu}) + \beta_5 \ln(\text{Super_danmu}) + \beta_6 \ln(\text{Ruser_grade}) + \varepsilon \end{aligned} \quad (4)$$

$$\begin{aligned} \ln(\text{Reward}) = & \beta_0 + \beta_1 \ln(\text{User_danmu}) + \beta_2 \ln(\text{Emotional_proportion}) + \beta_3 \ln(\text{Fans_proportion}) \\ & + \beta_4 \ln(\text{Enter_danmu}) + \beta_5 \ln(\text{Super_danmu}) + \beta_6 \ln(\text{Ruser_grade}) + \beta_7 \ln(\text{Enter_Danmu}) \\ & * \ln(\text{Ruser_grade}) + \varepsilon \end{aligned} \quad (5)$$

$$\begin{aligned} \ln(\text{Reward}) = & \beta_0 + \beta_1 \ln(\text{User_danmu}) + \beta_2 \ln(\text{Emotional_proportion}) + \beta_3 \ln(\text{Fans_proportion}) \\ & + \beta_4 \ln(\text{Enter_danmu}) + \beta_5 \ln(\text{Super_danmu}) + \beta_6 \ln(\text{Ruser_grade}) + \beta_7 \ln(\text{Super_Danmu}) \\ & * \ln(\text{Ruser_grade}) + \varepsilon \end{aligned} \quad (6)$$

The final hierarchical regression results are shown in Table 6

Table 6: Hierarchical Regression Results

	model (3)	model (4)	model (5)	model (6)
Constant	3.610E-15(1.000)	3.459E-15(1.000)	0.005(0.837)	0.004(0.867)
User_Danmu	0.441(0.000)	0.441(0.000)	0.439(0.000)	0.439(0.000)
Emotional_proportion	-0.053(0.072)	-0.043(0.117)	-0.044(0.107)	-0.043(0.111)
Fans_proportion	0.066(0.033)	0.089(0.002)	0.088(0.002)	0.090(0.002)
Enter_Danmu	0.112(0.000)	0.080(0.003)	0.076(0.005)	0.081(0.003)
Super_Danmu	0.145(0.000)	0.139(0.000)	0.139(0.000)	0.140(0.000)
Ruser_grade		0.319(0.000)	0.278(0.000)	0.276(0.000)
Ruser_grade* Enter_Danmu			-0.034(0.019)	
Ruser_grade* Super_Danmu				-0.048(0.023)
F	F=102.265,P=0.000	F=130.440,P=0.000	F=113.067,P=0.000	F=112.970,P=0.000
R ²	0.321	0.420	0.422	0.422
Adjusted R ²	0.317	0.416	0.419	0.419

Table 6 shows the results of the hierarchical regressions, all models passed the F-test and were statistically significant. From models (5) and (6), it can be seen that the regression coefficients of the interaction terms of Enter_Danmu and Super_Danmu with Ruser_grade were -0.034 ($p=0.019<0.05$) and -0.048 ($p=0.023<0.05$) respectively, and the R² of the models were both increased, so there was a moderating effect. The main effect of Enter_Danmu and Super_Danmu was positive, and the

regression coefficient value of the interaction term was negative, so their positive effect on rewards would be attenuated by the level of reward users, and H6 and H7 were also supported.

Results

Based on interactive ritual chains and signaling theory, the study investigated the influence of Danmu features on users' reward in a live streaming scenario and how personal experience moderates the relationship between the two. Through the collection of data and the construction of an empirical model for hypothesis testing, the study obtained three main conclusions.

1. The number of user Danmu, the proportion of fan Danmu, the number of user access Danmu and the number of super Danmu have a significant positive effect on reward. A large number of Danmu shown on the screen during a live room can, on the one hand, indicate that audience in the live room at this time talk more about common concerns, interact more frequently, and accumulate higher emotional energy, so the behavior of giving interactive feedback and performing emotional catharsis through rewarding is also raised. On the other hand, a large number of Danmu allows users to learn more about the content of the live room, reducing information uncertainty and increasing the likelihood of users rewarding. The higher the proportion of fan feeds, the more interaction there is between the same group of people, and the more audience is rewarded for standing out from their fans, expanding their influence, and gaining greater emotional rewards. The incoming Danmu provide information about the users watching the live room, making the audience aware that there are indeed more other audiences in the room and that their actions are visible to these users. Large rewards from other live rooms can easily attract the attention of users due to their unique special effects, and the audience is likely to reward the anchor later out of a sense of comparison or imitation.
2. The hypothesis of the effect of emotional proportion on reward is not supported. On the one hand, in a live room, all users are anonymous and are able to express themselves freely under the constraints of their real identities. Based on this, many users send negative or extreme messages in anonymous scenarios, and therefore audience have little trust in the content of Danmu. On the other hand, there is a limit to the area where Danmu can be displayed in a live room, and when there are more Danmu, the Danmu will quickly drift by, and information overload will lead to lower user engagement (Tang *et al.*, 2017), and users' judgments of emotion may be lower than actual, so the actual proportion of emotion does not have a significant impact on the reward.
3. Personal experience weakens the impact of the number of user access Danmu and the number of super Danmu on the reward. When individuals are experienced, the degree of information asymmetry is low, the audience is aware of the presence of audience in the live room watching together and can judge the number of audience in the live room according to their previous experience and have a clear perception of the effect of reward, and do not need the information contained in the signal of system Danmu to aid their judgment, so the impact of system Danmu on users' reward becomes lower.

CONCLUSION AND DISCUSSION

This study examined the effects of the audience's primary method of interaction, the Danmu, on the interactive feedback and emotional consumption patterns of viewers during live streaming. It also looked at the role that the audience's cumulative live experience—that is, personal experience—plays in adjusting the audience's behaviors during live broadcasts. Data on users' Danmu and reward behavior when viewing live streaming from the well-liked live room of the live broadcasting platform are collected for the research using data crawling technology. The Danmu features, rewards, and personal experience indexes are then built from the data acquired utilizing data processing and text analysis technology. Finally, it is proven through correlation and regression analysis that the number of user Danmu, the proportion of fan Danmu, the number of user entry Danmu, and the number of super Danmu will all significantly improve users' reward, and that the relationship between system Danmu and reward behavior is significantly influenced by personal experience. The following three aspects are the main focus of the research for this paper:

1. One of the key elements of online culture sector is live streaming. Despite the enormous number of consumers, the market is still expanding. It will continue to be one of the most well-liked industries in the future. Such a thriving industry has drawn significant corporations' attention in addition to a sizable number of professionals and academics interested in studying it. Since live streaming has only recently gained popularity, its format and content are continually evolving, and study on the subject lags behind. As a result, internet live streaming research is still in its infancy. Studying user reward behavior from a crucial component of live streaming, the Danmu, is extremely essential in light of the new media, live streaming on the Internet. Currently, research on online live streaming mostly focuses on platform-based marketing mode exploration, with e-commerce live streaming receiving increasing attention due to its potential for significant financial gains. This study broadens the research area for online live streaming by focusing on the live broadcast format with incentive as the primary profit-generating strategy. The majority of the research methodologies employed in the study were questionnaires and interviews because live streaming data is difficult to get. Because there is a little amount of experimental data, measurement error, social expectation deviation, and experimental subject conduct may all have an impact on the data, which could lead to results that are not precise enough. Since the data used in this study were created by actual users in a real-world setting closer to their actual ideas, the experimental findings are more trustworthy and widely accepted. The experimental findings can offer greater theoretical backing for the platform and user development.
2. According to research, the barrage will have an impact on audiences' reward behavior during live streaming. Using the interaction ritual chain theory, user in live room, Danmu is a crucial interactive method, and the reward is the interaction's feedback. There are more benefits the greater the interaction. Users are rewarded for chasing unique status and standing out from the crowd as well as for showing off. The system Danmu signal gives users information about the audience size

and the impact of rewards in the live room, aids in evaluating the social worth of rewards, raises users' likelihood of reward, and lessens audience demand for information as personal experience builds. The research found that the number of user Danmu, the proportion of fan Danmu, the number of user entry Danmu, and the number of super Danmu will all significantly improve users' reward, while personal experience will weaken the positive impact of the number of user access Danmu and the number of super Danmu on the impact of user reward.

3. The following recommendations for live broadcasting platforms, anchors, and viewers can be made using the findings of this study on the influence of Danmu properties on users' rewards. The system Danmu is one of the strategies the live broadcast platform can use to increase money. The platform might take part in the live streaming in this fashion. the user access Danmu can enhance the sensation of immersion, help the audience experience their own and others' existence, and make it simpler to accumulate emotional energy. An external indication that alerts the viewers to competition in the live room is the super bullet screen from other live rooms. It will be simpler to reward the audience in order to satisfy their emotional requirements for self-expression and to increase the competitiveness of the live broadcasting room where the crowd is. The platform can continually develop and improve the special effects of its many features, particularly the ones that are shown in each live room once users donate a significant amount of money. This will increase the platform's advantages. The live room can become more popular, draw more audiences, and provide the anchor with more financial rewards by upping the frequency of engagement there and encouraging viewers to take part. The first step the anchor can take is to boost audience engagement by inviting more people to participate in the Danmu interaction, sending the Danmu, increasing the number of user Danmu, and encouraging audience reward-willingness. Second, it's important to boost the proportion of fans in the audience, establish symbols like fan-exclusive medals, strengthen fans' loyalty to the live room, motivate fans to send Danmu, keep the live room buzzing, and raise live streaming revenue. The audience in the live room needs to be aware that the Danmu could affect their reward behavior if they take part in the live streaming. In order to maintain rational consumption and reward rationally, it is necessary to reduce and shield the Danmu appropriately and reduce the unnecessary expenses under the influence of the Danmu. Live streaming was a significant means for the public to be entertained throughout the epidemic time, and the habit of watching live streaming has been kept after the epidemic. We cannot allow live streaming to control our lives and we should have moderate amusement instead of indulging in it.

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The influence of product color displayed on online advertisements and consumer personality on purchase intention: The moderating role of age and gender

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ABSTRACT

Consumer purchasing patterns has been affected by COVID-19 health Crisis. Thus, companies must adapt to this change by focusing on understanding the different variables affecting the post pandemic purchase intentions of consumers. Therefore, the basic objective of this study is the development of an integrated framework to investigate the impact of the colors used for products on online advertisement and the consumer personality on the purchase intention of customers in the context of post pandemic. This study will also focus on highlighting the moderating role of age and gender on the relationship between the three constructs. Data were collected from customers of 53 Moroccan textile companies operating in the E-commerce industry. The data was analyzed, and the theoretical model was validated using Partial least square (PLS) and structural equation model (SEM). The findings show that: the color of the product displayed in the advertisement has a high impact on the purchase intention of consumers; the personality of the consumer impact positively the purchase intention of the consumer, and finally, color of the product displayed on the advertisement has a bigger impact on the purchase intention of young people than old people while age doesn't have any significant impact on the relationship between personality and purchase intention. The contribution of this study is to emphasize the roles of understanding the use of colors in advertising and the personality of the consumer, during the post pandemic, on consumer purchasing intention, for companies to innovate and differentiate their offered advertisements to meet the needs and survive the crisis.

Keywords: Color perception, advertising, consumer's personality, purchase intention, post pandemic COVID-19.

INTRODUCTION

Nowadays, the globalization and the competition over consumers push companies to search for creative methods to influence and attract more consumers. Therefore, companies are obliged to go beyond the classical marketing tools. Sensory marketing is one of the new marketing concepts that was introduced in the marketing literature for the past few years. This concept suggests using human senses to create the emotional characteristics of product and to secure strong relations with a consumer (Funk & Ndubisi, 2006; Hultén, 2011; Kosslyn & Thompson, 2003). It also suggests the use of colors to create a competitive advantage, reinforce loyalty, and increase number of intentions to shop again. Thus, understanding the consumer's color perception towards products can have a powerful impact on driving his purchase intention. In addition, understanding aspects such as the consumer's personality will help the company to understand the consumer and his purchase intentions. He et al. (2018) in his study related to electronic vehicles products, argue that some dimensions of consumer's personality have a significant influence on consumer purchase intention of products.

However, with the increase of digital development of new technologies, and after the COVID-19 pandemic crisis, consumers became more oriented to shop using online platforms. This obliged companies to focus more on creating and developing online advertisement to target more consumers. Consequently, the object of this study is to research empirically the consumer's color perception and his personality depending on two demographic factors: gender and age.

THEORETICAL BACKGROUND, MODEL, AND HYPOTHESIS:

The Consumer's Purchase Intention

The concept of purchase intention and more specifically online purchase intention is one of the intensive research areas in the existing literature. The online purchase intention is the situation where a customer is willing to be involved in an online transaction (Ling et al., 2010; Pavlou, 2003). It helps determine the strength of the consumer's intention to perform a specific shopping behavior through the Internet (Salisbury et al., 2001). Furthermore, the reasoned action theory suggested that consumer behavior can be predicted from intentions that correspond directly in terms of action, goal, and context of that same behavior (Ajzen and Fishbein, 1970). Thus, understanding online purchase intentions of customers helps to predict their behaviour towards a certain product or service.

In this study, three items were chosen from the literature to measure consumers' online purchase intention (Chen & Barnes, 2007; Gefen, 2000; Gefen & Straub, 2004; Pavlou, 2003; Shim et al., 2001). These elements include:

- Willingness to transact with the company's online shop in the near future.
- The intention to use the retailer's online shop.
- Prediction to use the retailer's online site in the future.

The perception of Color

Recently, color has occupied an important place in advertising. According to Pantin-Sohier and Brée (2004), a colorful advertisement activates the affective dimensions, unlike the cognitive dimensions which will be activated when faced with a black and white advertisement. Furthermore, Mayol and Gay (2008) assume that colors used in advertisements play a crucial role in attracting attention and trigger more emotional reactions.

The level of Color Activation (Physiological and Psychological Dimensions) :

The level of activation is apprehended through indicators of a physiological or psychological nature. For the physiological dimension of color, authors highlight the dynamogenic power of color (which increases with its wavelength). According to Nakshian (1964) and Wilson (1966) red color has a more stimulating effect on the body as it induces higher levels of activation and attract the attention. Therefore, red is described as more stimulating and exciting, and captures respondents' attention. For the psychological dimension of color, authors emphasize the capability of colors to provoke emotions. Color activates affective dimensions (Dooley and Harkins, 1970), and individuals who select warm colors have shorter reaction times and seem more receptive to stimuli, while the ones who choose cold colors tend to be more selective in their responses and choices (Bjerstedt, 1960).

Ability of colors to attract attention (marketing dimension):

The main role of colors in the field of marketing is to attract the attention of consumers, both at the point of sale and in communication. Bellizzi and Hite (1992) shows the importance of using cool colors in stores when consumers will be forced to make reasonable choices and warm colors when they will be encouraged to make impulse purchases. Therefore, colors have an effect on consumers' behavior. Red, for example, is an exciting color, while blue reflects calmness, relaxation, simplicity and peace. Thus, the colors influence rise the importance to understand the color perception of consumers and its impact on the purchase intention.

Perceptual illusions.

The volume of an object or a space can appear larger or smaller depending on whether it is light or dark (Kwallek, 1996). Size of certain shapes or objects can be overestimated depending on whether they have warm (yellow, red) or cold (blue, green) colors (Dérivé, 2000). In addition, color is able to modify the perception of the weight and size of objects (Bevan and Dukes, 1953; Warden and Flynn, 1926). Therefore, we have the following hypothesis:

H1. The perception of products color used in online advertisements has a positive effect on consumer purchase intention.

Personality:

Personality traits are defined as enduring, cross-situational consistencies in behavioral and response patterns (McCrae, 2009). In personality psychology, individual differences are well summarized within five broad, high-level traits or "domains": emotional stability, extraversion, agreeableness, openness-to-experience or intellect, and conscientiousness (Goslin et al., 2003; John et al. 2008; McCrae 2009).

Building on that progress in personality psychology, research on consumer personality has been similarly developed (Bosnjak et al. 2007; Endler and Rosenstein 1997). Research has found strong relationships between personality traits and consumers' specific cognitive and emotional responses to advertisements (Haugtvedt et al. 1992; Mooradian 1996). In that context, Ozbek et al. (2014) consider that personality is linked to different responses against the similar instances.

Personality Measurement:

Gosling et al. (2003) developed an extremely brief measure of the Big-Five personality dimensions called the Ten Item Personality Measure (TIPI). The TIPI is a 10-item measure of the Big Five (or Five-Factor Model) dimensions. The Big-Five framework is a hierarchical model of personality traits with five broad factors. Each bipolar factor (e.g., Extraversion vs. Introversion) summarizes several more specific aspects (e.g., Sociability), which, in turn, refers to a large number of more specific traits (e.g., talkative, outgoing) (Goslin et al., 2003). The Big-Five framework suggests that differences in human personality can be classified into five broad, empirically derived dimensions: Extraversion, Agreeableness, Conscientiousness, Emotional Stability, and Openness to Experiences.

Therefore, analyzing patterns of personality traits and their effects is crucial for understanding consumer behavior (Lissitsa & Kol, 2019). Lissitsa and Kol (2019) showed, in their study, the link between the big five personality traits and shopping intentions of hedonic products among four generational cohorts: baby boomers, generations X, Y, and Z. Moreover He et al. (2018) state that some personality dimensions had a significant influence on consumer purchase intention of products related to electronic vehicles directly and indirectly. Therefore:

H2. Consumer personality has a positive effect on his/her purchase intention.

The moderating role of gender in the relationship between personality and consumer purchase intention

Gender:

Gender differences have been observed with respect to information processing and behavioral responses (Xue et al. 2020), as it is an influential variable in consumer behavior research. From a psychological perspective, women's trust depends on emotions and men's trust depends on cognition, which is consistent with the empathizing–systemizing theory (Riedl et al., 2010). In conventional buying, researchers found that emotional factors are more important than functional concerns for women, while it is the opposite for men (Dittmar et al., 2004). Therefore, there are significant differences in the way men and women process information. Men tend to handle advertising information in a heuristic manner, while women are the opposite (Papyrina, 2015). Regarding the reaction of women to advertising information, a non-linear relationship exists between the number of arguments and effectiveness of advertising. Unlike men, women adopt a more detailed and selective approach with respect to advertising information (Kempf et al. 2006; Papyrina, 2015).

Additionally, research showed women to be thorough processors of information as they analyze objective as well as subjective product attributes; in the contrary, Kempf et al. (2006) note that men exhibit a tendency of applying off-the-shelf information to establish brand judgments. Thus, men use heuristic strategies to process, while women process information with details and pay more attention to small cues.

Some researchers such as (He al.,2018) state the moderating role of gender on the effect of some personality traits on purchase intention. Men and women behave differently, and this difference can be explained by the different socialization process that men and women undergo (Blocker and Eckberg, 1997; Davidson and Freudenburg, 1996). Moreover, previous research found that women have a more positive attitude towards some products than men (Schahn and Holzer, 1990).

Age:

Studies have shown that there have been significant differences among age groups in terms of perceptions and attitudes towards products, and specifically luxury brands (Hauck and Stanforth, 2007; Schade et al., 2016). Studies in the literature focus either on the younger (Budac & Baltador, 2014; Phau & Leng, 2008) or the older age groups of consumers (Amatulli et al., 2015). Therefore, age is a significant demographic factor that groups attitudes, motivations, and other psychological traits (Diehl and Hay, 2011). A study by Hellevik (2002) describes that “differences in value orientation between age groups are larger than the differences found for any other social background variable” (p. 286). Thus, the product choice for old consumers is generally limited (Rocha et al., 2005), while young consumers desire to express their strong uniqueness for personalized fashion products. Similarly, Schade et al. (2016) showed that further research should consider age as a moderator in various relationships.

The consumer's socio-demographic characteristics such as age and gender, seem to have the power to moderate the existing relationships between the independent and dependent variables. In fact, variables such as gender and age can be considered moderating variables that systematically modify the magnitude, intensity, meaning and/or form of the effect of an independent variable on a dependent variable (Sharma et al., 1981). In other words, the link observed between two variables will be different according to the gender of the individual or even according to his age. It is therefore possible to put forward the following hypotheses:

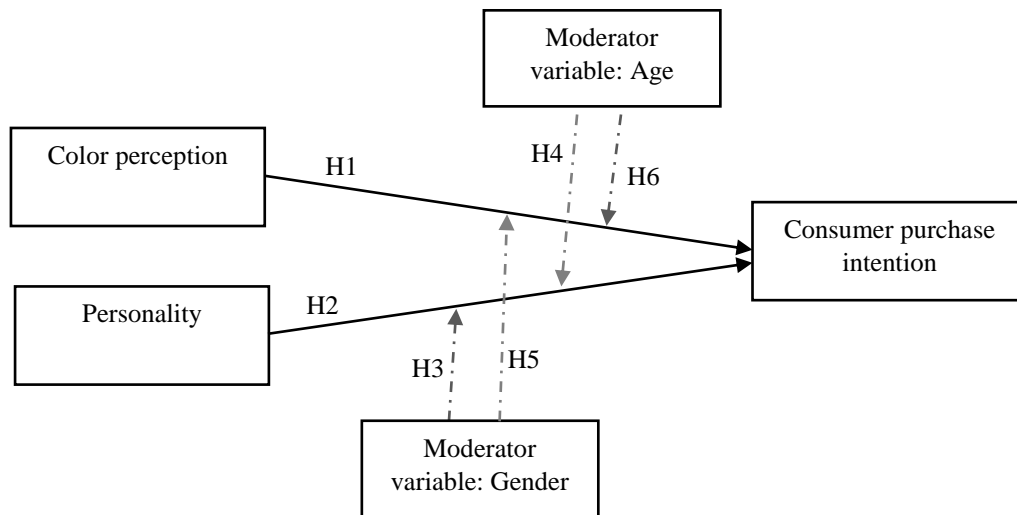
H3. Gender exerts its moderating impact on the relationship between consumer personality and his/her purchase intention.

H4. Age moderates the relationship between consumer's personality and his/her purchase intention.

H5. Gender exerts its moderating impact on the relationship between color perception and consumer purchase intention.

H6. Age moderates the relationship between color perception and consumer purchase intention.

Based on hypotheses, it is therefore possible to assume that gender and age represent two moderating variables that can have an impact on the relation between color perception of products in advertisements and consumer purchase intention. This relationship is represented schematically in the conceptual model the following figure 1.



Source: This study

Figure 1: Theoretical model

METHODOLOGY AND SAMPLING:

The analytical studies on the purchase intention of the consumer developed in the previous studies cited above do not allow an exhaustive vision of the impact of the color of the products displayed in the advertisements and the consumer personality on the purchase intention. In this study, quantitative analysis by empirical study was used to test the conceptual model in Figure 1 and the hypotheses presented above.

For this study, a focus group discussion comprising 20 customers 8 males and 12 females was conducted. The collected information were analyzed through content analysis, and statements were generated and grouped under various constructs. Thus, a questionnaire was developed, based on the group discussion and the literature review, and deployed using structured questions to help respondents assess color preferences and personality along with their perceived opinion about their purchase intention.

Although the questionnaire was in English, some questionnaires were translated into French using the parallel translation method (Kalay & Lynn, 2014) to avoid language barriers and to make it easier for respondents who did not speak English since French is the second spoken language in Morocco. In addition, two experts from e-commerce textile industry were requested to look at the questionnaire to check for content validity and resolve any difficulties in understanding the questions.

To test the hypotheses, the scales of the variables of this research were derived from the compilation of different studies (table 1), since the use of existing scales of measurement can present several advantages for the researcher: guaranteeing a certain level of objectivity, saving time, and a possibility of greater generalization (Nunnally and Bernstein, 1994). The measurement of the dependent variable (Consumer purchase intention) consists of items developed based on constructs used in the studies of Chen and Barnes (2007), Gefen (2000), Shim et al. (2001), Pavlou (2003) and Gefen and Straub (2004). Measurement items of personality come from the study of Gosling et al. (2003) who developed an extremely brief measure of the Big-Five personality dimensions : Ten Item Personality measure (TIPI). Perception of colors was measured using items developed from the studies of Divard & Urien (2001) and Pantin-Sohier & Brée (2004). Gender and age group were used as moderator variables. For the gender we had two categories (Male and female), and the group of age was defined as young (26 years and below) and old (27 years and above).

This empirical study was conducted on textile e-commerce companies. The textile and clothing sector was chosen because it is ranked second in the best-selling online items in Morocco, and the purchase of clothing during the pandemic has experienced a significant growth in the e-commerce sector. Consequently, this sector has the potential of benefitting from understanding the impact of colors of products displayed in the advertisements and the personality of the consumers from all genders and ages in their purchase intention during the post pandemic. Sample selection was carried out using a database of 53 e-commerce textile and clothing companies in the region of Grand Casablanca in Morocco. We drew a sample of 320 customers of different ages and socio-professional categories, using systematic random sampling. After selecting our sample, we contacted each consumer by phone, email and via Facebook to explain the purpose of the survey and request to participate in our study.

The research was conducted in compliance with certain ethical responsibilities, such as respecting respondents' choices of not responding to questionnaires and protecting their anonymity. The participants were asked to state their perceived opinions about colors of products in advertisement, their personality, and their purchase intentions. Constructs were measured using items on a 7-point Likert type scale ranging from 0 to 7 (0 = strongly disagree, 7 = strongly agree).

Table 1: Items measures

Constructs and scale items	Standardized loadings
Purchase intention (PI)	
I have the intention to shop online	0.665
I am likely to make purchases online in the future	0.780
I plan to shop online in the future	0.846
Given the chance, I intend to buy online	0.707
The perception of colors (PC)	
Red color's attraction and caption of attention	0.860
Warm colors attraction of attention	0.606
Cold colors attraction of attention	0.845
Colors of products attract your attention before purchasing	0.819
Colors of the product influence ,sometimes, your perception of the product's weight and size	0.876
Personality: TIPI scale scoring by Gosling et al. (2014)	
Extraversion (Extraverted, enthusiastic/ Reserved, quiet)	0.763
Agreeableness (Critical, quarrelsome/ Sympathetic, warm)	0.809
Conscientiousness (Dependable, self-disciplined/ Disorganized, careless)	0.588
Emotional stability (Anxious, easily upset/ Calm, emotionally stable)	0.780
Openness to experiences (Open to new experiences, complex / Conventional, uncreative)	0.763

Source: This study

EMPIRICAL RESULTS:

Table 2: Results of reliability, convergent and discriminant validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Colors	0,866	0,898	0,902	0,652
Purchase intention	0,753	0,790	0,838	0,567
Personality	0,788	0,804	0,853	0,541

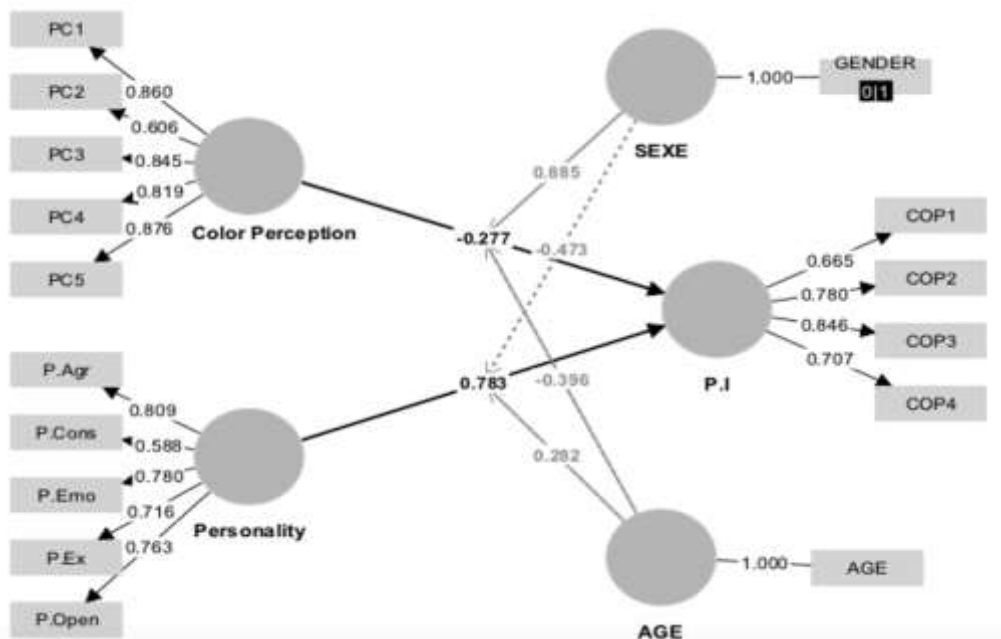
Source: This study

To identify the internal consistencies of various statements framed in the research work, Cronbach's Alpha was used. As seen from the above table (Table 2), the value of Cronbach is greater than 0,7 for all the dimensions, which indicates sufficient internal consistencies of the statements framed in research work and shows that the data collected is reliable (Lin and Huang, 2008).

In addition, the convergent and discriminant validity were satisfied. The composite reliability for each construct was greater than 0,7 and the average variance extracted (AVE) was more than the minimum requirement of 0,5 (Fornell & larcker, 1981). The discriminant validity was tested and satisfied using the heterotrait-monotrait ratio (HTMT) criterion, and the HTMT value between any two reflective constructs was <0,9 (Henseler et al., 2015).

In this study, SmartPLS 4 software was used to apply the partial least square (PLS) method for the development and test of the path model and the estimation of the measurement and structural parameters in the structural equation model (SEM) (Chin, 1998). In addition, the use of PLS-SEM was opted following Sosik et al. (2009) suggestion to use the PLS approach due to the relatively small sample size. We used AMOS 16 to conduct confirmatory factor analysis (CFA) to assess the validity and reliability of the constructs (Hair et al.,1992). CFA indicates a good fit for the theoretical model. For this study, the loading factors of the items were greater than 0.4 and ranged from 0.50 to 0.84. This shows that the items are significant according to Straub et al. (2004).

In this study, out of the 6 hypotheses, 2 are not supported (Table 3). Variance inflation factor (VIF) was used to test the multi-collinearity problem for each construct, and the value of VIF was seen below the threshold of 3.33 (Diamantopoulos and Siguaw, 2006). In addition, the highest correlation was seen between personality and consumer purchase intention ($r=0.783$, $p<0,05$), while the correlation between colors perception and consumer purchase intention is insignificant.



Source: This study
Figure 2: Relationship paths

The outcomes of the hypothesized relationships for testing the moderating effect of gender and age reveal that moderating effect of gender is supported in H4 but not in H3. Thus, gender moderates the relationship between color perception and purchase intention but not the relationship between personality and purchase intention. The impact in the H4 is seen more for females than males. One of the reasons to explain this could be that females are more inclined to be selective with colors while purchasing products. Thus, their color perception is higher.

Table 3: Results of reliability, convergent and discriminant validity

Hypotheses	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values	Supported/Rejected
Colors perception → Purchase intention	-0.277	-0.280	0.209	1.325	0.186	Rejected
Personality → Purchase intention	0.783	0.794	0.173	4.534	0.000	Supported
Gender x Personality → Purchase intention	-0.473	-0.499	0.373	1.266	0.206	Rejected
Gender x Colors perception → Purchase intention	0.885	0.944	0.393	2.252	0.025	Supported
Age x Personality → Purchase intention	0.282	0.291	0.106	2.656	0.008	Supported
Age x Colors perception → Purchase intention	-0.396	-0.397	0.119	3.334	0.001	Supported

Source: This study

For the moderating effect of age, H5 and H6 are both supported which show that age moderates the relationship between personality and consumer purchase intention as well as the relationship between colors perception and consumer purchase intention. This also shows that age moderates the relationship with young customers demonstrating high impact of their personalities and colors perceptions to drive their purchase intention through online platforms compared to old customers. In addition, the relationship between colors perception and consumer purchase intention is significantly higher for young customers than old customers. This can be explained by the fact that young consumers in Morocco are more inclined to new technologies and prefer to use online platform to shop and follow the latest trends of colors and fashion, while old customers still prefer to shop offline.

DISCUSSION:

This research includes an analysis to test the influence of colors perception and the consumer personality on his/her purchase intention, along with the moderation of gender and age on the relationship between the three variables during the post pandemic of COVID-19 crisis. Our empirical research results presented in this paper revealed that color perception depends on demographic factors of consumers (age, gender) to impact their purchase intention. In addition, this study disclosed that personality of the consumer influences his/her intention to buy, and that this intention can be increased for young consumers more than old consumers. These results corroborate with the findings of Sliburyte & Skeryte (2014) who argued that the consumers' color perception depends on the demographical factors (Age, Gender, Education) to influence his/her decision to buy.

Fours of the 6 hypotheses were significantly supported based on data collected from 320 customers of 53 E-commerce textile companies. Results showed that colors of products displayed on advertisements of these companies impacts the purchase intention of young consumers more than old consumers. In other words, companies who integrate vivid colors of products in their advertisement have higher demand in terms of young customers, especially during the post pandemic of COVID-19 crisis where online advertisement are very important to reach consumers. This study also confirmed that personality of consumers impacts their purchase intention. As new technologies become widespread, reaching more consumers through digital platforms becomes easier. Moreover, the current COVID-19 crisis had a huge impact on the change of personalities of different customers which made the majority of customers dependent on digital platforms for purchasing more than ever before. Therefore, understanding the different aspects of personalities of consumers along with their age and gender is necessary to create customized product colors and chose the adequate ones for advertisement.

Textile E-commerce companies need to focus on carefully chose the product colors displayed on their online advertisement to meet the changes in their consumers' preferences and personalities and add value to stimulate their purchase intention.

IMPLICATIONS AND CONCLUSION:

Our empirical research results presented in this paper revealed that companies can successfully reach more customers by carefully choosing the adequate colors of products in their online advertisement according to the age and gender of their customers while considering the key factor of customers personality. The results of this study can be applied by the Moroccan e-commerce companies to build brand uniqueness as creative advertisers during the post pandemic of COVID 19. Marketing managers have to focus on improving and adjusting their digital marketing strategy of advertisements according to the age and the gender of the customers. Moreover, e-commerce companies must carefully choose the colors displayed in the advertisement to attract the maximum number of potential consumers.

However, this research has several limitations. This study was conducted using a limited sample size. A larger sample size would probably have allowed a greater generalization of the results .Thus, further studies can consider bigger samples. Moreover, the choice of one type of products (textiles and clothing) is rather limiting in terms of results. A study of at least two different types of products would have allowed better generalization. Another research perspective that could be interesting is to conduct a cross-cultural study to verify whether the moderating role of gender and age is different according to the culture of the individual.

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The rising of livestream business model: Insights from the case study of TikTok in the UK

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ABSTRACT

Consumer purchasing behaviours have experienced a revolution from offline shopping malls to social media Livestream during the last decade (Sorescu et al., 2011). This study adopts the case-study approach and an online focus group with the managers of TikTok trading business in the UK to examine how TikTok's retailing path can help brands or sellers build a close tie with consumers. This paper concludes with how the TikTok Livestream commercialization pathway impacts the conventional business model. Three conclusions are drawn from this study. Firstly, a video creator who holds the Intellectual Property of a TikTok account plays an essential role as the Livestream video influencer. They have created value for their followers and drive consumers' intention of purchasing behaviour. The livestream of video creators provides opportunities for consumers to interact with the video creator and other consumers. Secondly, Livestream video shopping breaks the limitations of offline physical space and attracts consumers efficiently. Thirdly, social e-commerce empowered by artificial intelligence technologies including image analysis and text analysis plays an essential role in targeting consumers and sustaining the operation of the Livestream shopping platform.

Keywords: Livestream shopping, business model, consumer behaviours, Livestream purchase

INTRODUCTION

Because of the growing impact of the social media platforms on users' daily lives (Sorescu et al., 2011), livestream services have emerged as an innovative retailing method. Livestreaming (M. Li et al., 2022) provides both merchants and consumers commercial and social support with its interactive and real time communication between video creators and consumers. Some studies and reports demonstrated that livestream commerce would grow unpredicted capital size (Liu et al., 2022). The livestream producers consist of brand manufacturers (Merritt & Zhao, 2022), conventional e-business platforms such as Taobao in China (C.-C. Wang & Chen, 2010), SMEs, social media users or video creators who promote the commercial products (Sheth & Kim, 2017). Brand manufacturers care more about the exposure of the brand on the internet and products related with the brand (Hudson et al., 2015). As the impact of social media on brand management, consumers play a more important role in sustain a brand (Gensler et al., 2013). For conventional e-business platform sellers in Amazon or eBay, it is very common for them to use the social media livestream to attract specific consumers and expand the market (Merritt & Zhao, 2022). SMEs use a location traceable function of the livestreaming recommendation system to track and influence potential local customers to place orders in their online or offline shops (Viu-Roig & Alvarez-Palau, 2020). For social media users and video creators, the website monetization model is the critical factor for the harvesting revenue stream (M. Li et al., 2022). Furthermore, social media livestream platforms, like TikTok, have launched a universal video creators' support plan and offline business partnership to attract more users to this vibrant online platform (H. Wang et al., 2021). As a new method for electronic business, a very nature research question to ask is, what are the specific features for the livestream to distinguish as a business model? What will drive users to purchase through livestream videos?

Many previous livestream studies focus on consumer behaviors under the livestream commerce setting. It is demonstrated that customer engagement (Cao et al., 2022) and impulse shopping behaviours (Merritt & Zhao, 2022) play key roles in accomplishing and strengthening the Livestream commercial model. Some research also reveals that customers' Livestream engagement is negatively related to Livestream revenue in a broader view (Liu et al., 2022). Viewers' visual attention track (Chen et al., 2022) and flow experience (H. Wang et al., 2021) within the live sale are also discussed and refer to shopping behaviours. User behaviours are also constrainedly explored from an internal perspective, like Zhu's work constructed the mechanisms of users' cognitive personalities and shopping intentions (Zhu et al., 2021). Most of the studies for Livestream shopping behaviors utilize experimental datasets. For example, Chen's work employed college students who are from the same age group for the experiments (Chen et al., 2022); Furthermore, these experiment participants rarely shop from social media livestream platforms, which confounded reality with the knowledge they contribute (K, Tomas, 2022). This research investigates TikTok Livestream features that influence purchasing behaviors from the real case study of TikTok Livestream producers. Thus, this article tries to explore the features of livestream business model by analysing TikTok Livestream merchants. It is expected to identify the profit chain in livestream commerce and provide practical implications for the future of the live streaming industry.

LITERATURE REVIEW

The literature review provides the evolutionary path of electronic business from e-commerce platform to social commerce, and livestream retailing.

E-Commerce and platforms

E-commerce was first defined by Dr Robert (Burt & Sparks, 2003; C.-C. Wang & Chen, 2010) as websites designed for online business activities capitalizing on internet to display and sell product/services to match the needs of consumers and suppliers. Starting from around the 2000s, many established e-commerce platforms have flourished, for example, eBay and Amazon in western world and Taobao and JD in China. The first generation of E-commerce websites only have the simple functions of displaying and selling products (Otto & Chung, 2000). As internet technologies developed the social media features have enriched the promotion and selling functions of e-commerce sites (Manquiquiz et al., 2021). Early e-commerce sites benefit from selling products online for cost reduction (Bakos, 2001; Netessine et al., 2006). In the early 2000s, even though researchers found it hard to investigate and understand consumer behaviours in e-commerce, while the related data was sparse at that moment (Burt & Sparks, 2003), positive impacts on brick retailers are reported (Otto & Chung, 2000; Molla et al., 2006). It is until 2010 that the retail logistics between consumers and suppliers are identified as transformed by e-commerce according to John's study (Fernie et al., 2010). E-commerce supply-chain literature (Boysen et al., 2019) reported that the e-commerce retailers controls the supply-chain relationships and warehouses to manage the successful business. For instance, JD and Taobao in China has integrated retail channels, logistics, and digitalization of retailing process to formulate a closed business loop system (Zheng et al., 2020). In summary, conventional e-commerce integrates retail, marketing, supply chain and financial-industrial to maximum efficiency, constructing a synergistic effect for a closing tie of supply-chain to improve total profit. Recent studies also imply more comprehensive e-commerce business model for sustainability (J. Li et al., 2018).

Social E-Commerce

Social e-commerce was first defined as internet word-of-mouth applications embedded into an e-commerce system (Liang & Turban, 2011). In 2019, Social e-commerce became one of the capital interests (H. Wang et al., 2021). Compared to traditional e-commerce, social e-commerce lowers the cost of acquiring new customers by promotions through social media interpersonal relationships (Zhang & Benyoucef, 2016). Social e-commerce characterizes three central identities to distinguish it from conventional e-commerce: theoretical, customer and design features (Busalim & Hussin, 2016). The growing technologies enhance shopping interactions and boost social e-commerce research interest and knowledge gaps (Ji et al., 2021). The existing social e-commerce models could be summarised as three mainstreams, social content commerce (B. Lu et al., 2016), social share commerce (Ji et al., 2021), and social e-retail commerce (Piotrowicz & Cuthbertson, 2014). Social content E-commerce platforms produce valuable, attractive contents to lead and educate consumers' perceived value and purchasing intentions (Y. Huang et al., 2019). The promoting environment of social content commerce could be summarised into four areas: policy (Gibbs et al., 2003), economics (Rawat & Divekar, 2014), public need (Ma, 2021), and technologies (Si, 2021). The business model of social content commerce and its profit construct is shown in Table 1.

Table 1 Social content business models and classifications

Type	Business Model	Profit Construct	Platforms
Closing type	Content operation	Platform rent for e-commercial entry and merchant service fee, advertisement, sales, branding marketing	Facebook/TripAdvisor/Redbook
Website Monetization	Content educational intentions to the third e-commercial platform	Selling commission and advertisement income	Instagram/YouTube

Source:(Zheng et al., 2020)

Social Sharing e-Commerce

Social sharing e-commerce relies on social network sharing and product advertisement earning (Cheng et al., 2019) as demonstrates in Table 2. Social sharing e-commerce acquires website traffic flow from share recommendation functions of social media and e-commerce platforms (Ji et al., 2021). Social media sharing valued content with users dramatically influences purchasing intentions and behaviours (Z. Huang & Benyoucef, 2013).

Table 2 Social share business models and classifications

Type	Business Model	Profit Construct	Platforms
Group purchase	Low-Price sensitive pursuing consumers within the e-commerce platform	Transaction commission and advertisement earning	Groupon/Pinduoduo
Sharing	Sentiment sharing and influencing consumer shopping intention to a traditional e-commercial shopping website	Transaction commission and cost-per-sale advertisement earning	TikTok/Facebook

Source:(Hsieh & Lo, 2021)

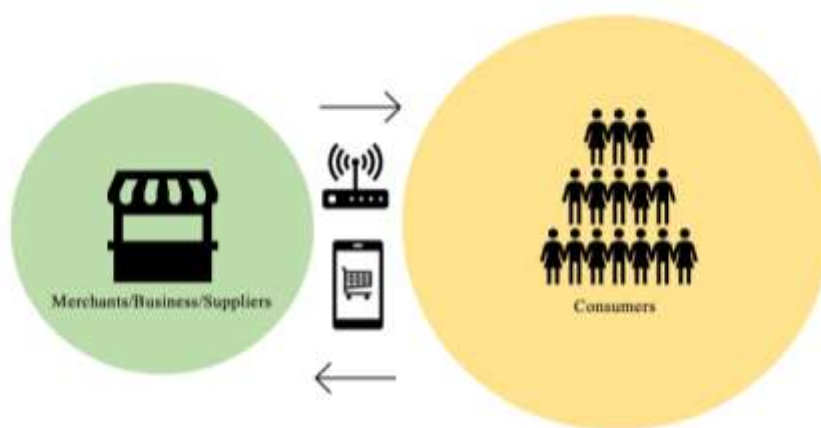
Social Retail e-Commerce

Social e-retail commerce refers to the e-commerce strategies that enables sellers to maximize the retail capability to reach stock optimization and gain growth of retailing turnover (Lefebvre et al., 2006). Previous research indicates that the social e-retail commerce could be achieved through omnichannel model driven by technologies (Gonçalves Curty & Zhang, 2013; Liang & Turban, 2011). In one study utilizing a longitudinal quality method and data collected from 100 Mechanical Turk workers, the result and analysis concluded that top e-retail commerce websites normally distinguish themselves from peers with social features (Gonçalves Curty & Zhang, 2013). Consequently, the overall retailing structure is reshaped with restructured retail logics (Fernie et al., 2010). Table 3 summarises current e-retail profit models and platforms. B-to-C refers to Business to Customer business model, and S-to-B-to-C refers to the Suppliers to business to consumers business model according to the traditional business model classification (Jimenez et al., 2019).

Table 3 Social e-retail profit models and platforms

Type	Business Model	Profit Construct	Platforms
B-to-C (See Figure 1)	Traditional retailers duplicate original business models to online commerce platforms to approach new consumer	Retail revenue and service fee	Offline Brand Merchant websites, e.g. (Tesco, ASDA, John Lewis, Harrods)
S-to-B-to-C (See Figure 2)	Suppliers seek e-retailers for marketing, logistics, technology, and training support. E-retail takes responsibility for managing social e-commerce platforms and business models to accomplish sales and website monetization.	Retail revenue and social marketing platform renting fee	Alipay social community/ Taobao social community

Source:(Y. Wang et al., 2022)



Source: (Bharadwaj et al., 2022)

Figure 1 Business-to-Consumer Social retail e-commerce Model



Source:(Fu, 2020, p. 2)

Figure 2 Suppliers to retail Business to Consumer (S-to-B-to-C) Social retail e-commerce Model

Livestream Retailing

Livestream service has become an emerging marketing strategy (W. Lu et al., 2022) recently due to its ability to advertise perceived value of products, build consumers' trust, and communicate interactively with customers (Xue & Liu, 2022). Livestream research literature highlighted the impacts of social e-commerce on traditional commerce industries (Cheng et al., 2019; Zhou et al., 2013). From the consumers' perspective, livestream has provided the opportunity to improve the information exchange process between consumers and merchants (Ma, 2021; Y. Wang et al., 2022). There are several studies discussing the livestream's value in retailing. Wymer et al. investigated live streaming interactive advertisement value (Value is summarised into four dimensions: immersion, immediacy, interaction, and sociality) for sports organization marketing using a case study approach (Wymer et al., 2021). Livestream marketing responds positively to consumers' behaviours and converts revenue (W. Lu et al., 2022). However, e-retailers are biased in coping with appraisals of the relationship between Livestream sales traffic and salespeople performance (Bharadwaj et al., 2022). There is also no discussion on livestream retail from the business model system.

METHODOLOGY

This paper utilized an in-depth and detailed case study of TikTok Livestream commerce in the UK. TikTok was chosen for this study for its successful retail strategy (Xue & Liu, 2022). TikTok was started up in 2016 as a short video sharing social media platform. The growth users of Tiktok usage has exploded exponentially and the average usage of TikTok for every user is 3 hours a day (Merritt & Zhao, 2022). With its entertainment feature and algorithm-based content recommendation system, TikTok soon started competing with popular social media platforms in the market (e.g., YouTube, Facebook, Instagram, etc.). In 2020, the TikTok UK site formally launched commercial Livestream service and open an innovative new business model in UK. Algorithms drive TikTok Livestream service, and numerous marketing phenomena behind algorithms need to be explored and explained. Our research accesses the TikTok retail pathways' impact on the product, price, marketing strategies, promotion effect, video content and Livestream performance. This case study involves the observation of 98 Livestream videos and an online focus group with 38 Livestream business owners or managers. Within the data collection process, this case study has two objectives, to identify the business model for livestream and features of livestream that can promote customers to purchase products.

Focus Group Design

This study designed a constructive framework for online focus group with the social media platform chatroom function at DOUYIN—a social media platform in China. Online focus group was chosen because it will provide an cheaper and easier method to collect qualitative data. Douyin was chosen to select the focus group members because many Tiktok users attend e-commerce training course in Douyin. The focus group members were identified with the recommendation of algorithms by typing hashtag keywords, Livestream workshop, start an e-retail business on TikTok, international trading business, business models etc. (Haenlein et al., 2020).

Focus Group Process

The focus group process describes in Figure 3 starts by looking for participants by typing keywords and hashtags (see the last paragraph) so that social media algorithms can search and recommend users based on the researchers' interest in the content and target people. The researchers have one anonymous account on social media, and the search targeting interviewees' tasks are all operated by the researcher's social media account. The researcher will follow all the target participants and remark on their background information by staying at the business training or business seminar theme chatrooms. There will be a shallow risk of ethical issues after getting their consent messages through the private Messenger function. The researcher also allocated a personal chatroom at DOUYIN with the hashtag "business model seminar" and "focus group room". The researcher "sat" at the host position with 298 responded participants in the group and answered questions in the chatroom with text and audio.

Participants on social media platforms are filtered by TikTok algorithms and automatically pushed to a homogeneous group of users (Eriksson Krutrök, 2021). It has been proved that people are more likely to express true feelings or views online since

anonymity and high privacy is a natural feature of social media (Gruber et al., 2008). Participants are selected on their careers and significant business background. Their age, gender, and education information are also recorded anonymously with the focus group question answers.

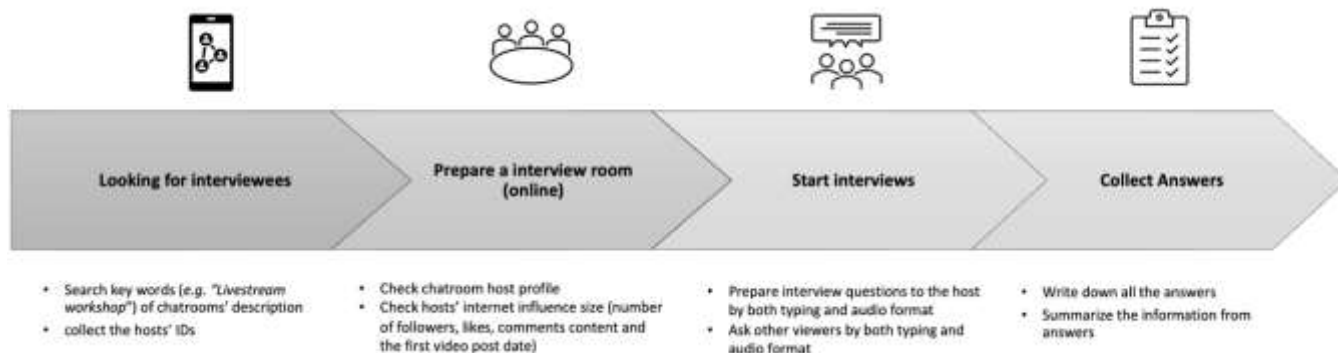


Figure 3 Interview process with participants and information collection

The focus group started with the introduction of the purpose of the research and consent to participate in the research was provided. The researcher started the discussion by eliciting some background information about the traditional e-commerce, followed by some challenges and experiences with the Livestream retailing. This topic attracts business owners with similar experiences. They started answered various questions related with the Livestream retailing. Questions discussed mainly focus on three areas, background of the livestream business and the owner, the content creation process, and the profit model of livestream retailing. Figure 4 demonstrated the focus group discussion framework and how the data was collected for content analysis.



Figure 4 Laddering Interview framework and the critical information from answers

Data analysis and results

This study used focus group to collect data and construct a hierarchical value map summarised in Figure 5. The primary objective of this study is to explore the knowledge of practical TikTok Livestream business experience. The focus group questions help the researcher to tap into traditional and Livestream e-commerce construct systems and elicit values, consequences, and attributes of all business models. The results summarised the e-commerce intrinsic value is website traffic and monetization. The Livestream e-commerce impact on traditional e-commerce is on marketing strategy value transfer. The revenue is redefined as website traffic multiplied by converting rates by new media e-commerce. Price per sale and repurchase rate is also pivotal for the sustainability of Livestream e-commerce. These results could be revealed in the difference in marketing strategies: Traditional e-commerce allocates more on product development and optimizing services. In contrast, social media e-commerce invests in pursuing website traffic and maximizing the consistency of products and business brand exposure. The attributes data indicate the discrepancy between sales and marketing methods: for expanding website traffic and Livestream sales marketing or committing to accomplishing services and better products.

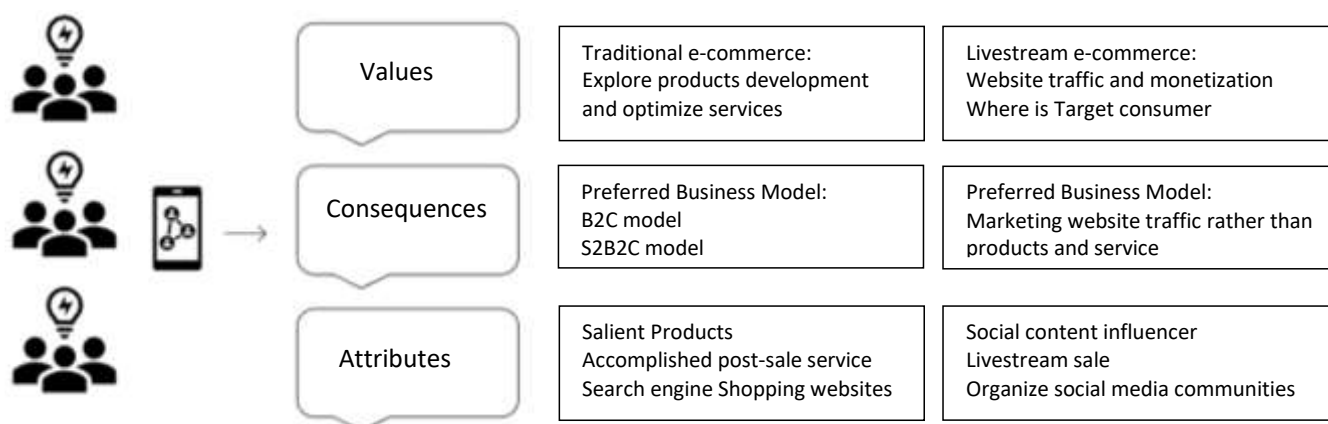


Figure 5 Interview analytics framework

DISCUSSION AND RECOMMENDATIONS

In previous studies, the attention economy impact was discussed in many media industries' revenue sources, for example, traditional media companies' revenue was gradually shifted from public sources to social media platforms and social share contents (Myllylahti, 2018). Social media revenue research findings reveal that technologies already impact and reshape the market and traditional business model imperceptibly (Goldmanis et al., 2010). From the case study investigating TikTok Livestream e-commerce, research demonstrated distinctive Livestream e-commerce models' value and consequences on traditional e-commerce. Earlier studies examine Livestream's e-commerce impact from consumers' perspective, the technologies drive media platforms to emerge and provide a new experience to stimulate social Livestream shopping behaviours and habits (Bharadwaj et al., 2022; W. Lu et al., 2022; Si, 2021; Zhu et al., 2021). Technologies' evolution reshapes human livelihood, hence consumers intend to shop online rather than go to brick stores (Molla et al., 2006; Otto & Chung, 2000). This progress sustainedly impacts consumers' behaviours and business owners' perceived value (Si, 2021). For future Livestream e-commerce business models, the suppliers will highly focus on pursuing traffic flow and Brand online/offline social networking impact. Profit stores in the consumers' attention, the capital will target to invade consumers' time and value perception as the market strategies (Myllylahti, 2018).

Recommendations for future new media e-commerce research provide insight into the new social Livestream e-commerce model by clarifying two facts: (1) The essence of the advanced e-commerce model is online traffic flow, which signifies figuring out where the consumers are. (2) The most appropriate marketing strategy for social Livestream or advanced e-commerce profit models is to maximize the business exposure rate online. The next phase is tapping into potential consumer groups, inducing interest through social content created on social media platforms. The end loop of the e-commerce model is converting purchase and repurchase rates. To encourage repurchase behaviour, forwarding and sharing the content will rely on the value and information communication between the merchants and consumers.

CONCLUSION

This case study focuses on TikTok Livestream e-commerce and practical retail facts in the UK. The focus group and analysis offer a diverse range of features and views of Livestream e-commerce for remodelling business cognitive value and propositions for marketing. The paper also clarifies the essence of commerce exchanges, and exchange promotes commerce value. An advanced commerce model entitles the business model to innovative value and promotes value exchange.

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The role of remixing for innovation in online innovation communities

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ABSTRACT

Potentially innovative ideas are being generated, shared, and even remixed (recombined) in the online innovation communities. These ideas create new innovations through remixing of ideas. In this study, we investigate how remixing makes ideas more innovative in online innovation communities. Our model is validated through ordinary least squares regression on a secondary dataset of 57,049 ideas collected from one of the largest 3D printing online innovation communities, Thingiverse.com. The result shows that the number of prior ideas has an inverted U-shaped relationship with the idea's degree of innovation and the cross-boundary remix has a positive effect on the idea's degree of innovation.

Keywords: remixing, innovation idea, prior ideas, cross-boundary remix, online innovation communities.

INTRODUCTION

With the recent development of the platform industry, the online innovation communities are also developing. Online innovation communities (OICs) are venues that give individuals the chance to exchange information, spark creativity, and promote the growth of innovation. (di Gangi & Wasko, 2009). In the past, when data was uploaded to a website for free, such as GitHub, other users could download or develop and upload it (Hata *et al.*, 2022). According to Ye *et al.* (2012), OICs are crucial for the development of innovative ideas. OICs are characterized by Gebauer *et al.* (2013) as wealthy sources of innovation that provide its participants additional advantages.

The OICs are designed to enable users to come up with creative ideas. Additionally, OICs are now acknowledged as crucial contexts for academics to comprehend the processes of innovation, in addition to being significant sources of innovation (Flath *et al.* 2017). Innovation is the generation, acceptance, and implementation of new ideas (Thompson, 1965). Innovations wouldn't exist in a vacuum; rather, they need some recombining of already existing components (Schumpeter, 1942; Weitzman, 1998). It has been recently that the notion of innovation through recombinations has received significant interest, due to the rise of open platforms and online communities (Cheliotis *et al.*, 2014; Oehlberg *et al.*, 2015; Stanko, 2016). In addition, user community innovation has become widespread in the real world. (Anderson, 2012). Therefore, the individual's ideas (i.e. innovations) emerge more regularly and effortlessly. Such individual's ideas are highly innovative and often develop new products (Von Hippel, 2005).

The concept of reusing pre-existing elements to produce something new is frequently described by the term 'remixing,' an established in the music industry (Flath *et al.*, 2017). However, remixing has frequently appeared not only in the music industry, but also within online platforms such as the OICs recently (Hill & Monroy-Hernandez 2013). The 2013 Green Paper on Copyright Policy, Creativity, and Innovation in the Digital Economy published by the U.S. Department of Commerce defines remixes as "works created through modifying and mixing existing works to make something new and creative." Accordingly, the literature related to remixing in the innovation communities is increasing. Studies on remixing in OICs have mainly been researched on remixing behavior (Stanko *et al.*, 2021) and what factors are influencing which innovations to be remixed (Tan *et al.*, 2020; Stanko, 2016). However, research on how remixing in OICs affects innovation ideas is sparse. This study identifies the impact of remixing on OICs in the current situation where various OICs are emerging. Therefore, our main research question is the following: How remixing makes ideas more innovative in OICs?

To answer this question, we collected data set from Thingiverse, one of the largest 3D printing OICs, and the findings of our study have several contributions. First, our study demonstrates an inverted U-shaped relationship between the number of prior ideas that were remixed and the degree of innovation of the new idea. The result indicates that, as the number of ideas used for remixing increases, the degree of innovation increases, but if too many ideas are used, the degree of innovation decreases. In addition, we examine the relationship between cross-boundary remix and an idea's degree of innovation. The result shows that the idea was more innovative when ideas were transferred to other fields during the remixing process.

LITERATURE REVIEW

The role of recombination in innovation

The terms *reuse*, *recombination*, and *remixing* are frequently used exchangeably. The management field has explored the problem of recombining existing ideas to produce something new. (Weitzman, 1998). Due to the development of online venues of information exchange, researchers' interest in the phenomena of recombinations has recently expanded. Schumpeter (1934) established the notion that innovation involves novel recombinations of information already in existence, which is where the idea of innovation as recombination first emerged. Such recombination-based innovation research has been conducted in the context of firm knowledge, scholarly knowledge production, patent, and open source development projects.

Scholarly knowledge production is one of the contexts in which the recombination for innovation has been studied. Uzzi *et al.* (2013) proposed that the most influential articles are likely to reference innovative combinations of prior information while still advancing conventional combinations. Similar to scholarly articles, patents contain references to other patents, and analyzing these references can help one grasp the context of a patented invention. (Albert *et al.*, 1991; Almeida, 1996). The hypothesis that invention is a recombination process is supported by an analysis of patent citations (Katila & Ahuja, 2002). Furthermore, the analyses of a firm's recombination support the hypothesis that the recombination of internal as well as external knowledge of a company creates innovation (Kneeland *et al.*, 2020; Arts & Fleming, 2018; Garriga *et al.*, 2013). Even though recombination is frequently discussed, especially in relation to OICs, little is known about how much remixing contributes to innovation.

HYPOTHESES DEVELOPMENT

In the OICs, users share their ideas and other users remix ideas as the source of innovation. Users generate a large number of ideas on a daily basis in the OICs. When a user creates an idea using prior ideas on an OICs, the user creates an entirely new idea using at least one of those prior ideas. It is through these prior ideas that the basis of remix will be laid, as well as a variety of inspiration for remixers. Additionally, individuals with a deep knowledge of a particular domain possess a more complex knowledge structure, so they can consider a greater number of knowledge reconfigurations with the domain to produce novel outcomes (Taylor & Greve, 2006). The level of innovation in a remixed idea will therefore be higher if it is based on more prior ideas.

Although prior ideas should increase its degree of innovation, this would be useful only up to a certain extent. For remixers in OICs, a large number of prior ideas to remix something new would lead to the situation of information overload. When the amount of information being exceeded the individual's capacity to process it, the information overload occurs (Morwitz, 2012). Due to the variety of prior ideas, it may be difficult to manage the remixing process and would likely exhaust the remixer's creativity and productivity. Hence, we suggest that there is an inverted U-shaped relationship between the number of prior ideas and the degree of innovation of ideas with appropriate prior ideas being more likely to be innovative.

H1. There is an inverted U-shaped relationship between the number of prior ideas and the degree of innovation.

Ideas from various domains exist within OICs. With accessibility that is an advantage of OICs, remixers can seek and use the domains they want or encounter with relative simplicity. Moreover, by merely viewing dispersed knowledge, individuals will get inspiration from a variety of domains and develop their own novel and creative ideas. Through this process, existing ideas will be remixed and either used for a new purpose in a different area or exist for a similar purpose in the same area. According to a study by Fleming *et al.* (2001), combinations of familiar knowledge can lead to combination exhaustion, yet recombinations of distant knowledge can provide the source of novelty. Compared to combining elements from the same domain, combining elements from different domains, triggers novel outcomes (Savino *et al.*, 2017). Therefore, even in the remix process, there will be a high degree of innovation if the prior idea's domain is shifted to a different domain. We propose that the cross-boundary remix is positively correlated with the idea's degree of innovation.

H2. The cross-boundary remix is positively correlated with the idea's degree of innovation.

DATA

Data source

To examine the relationship between the degree of innovation and remixing process, we obtained our dataset from Thingiverse (<http://www.thingiverse.com>) which is one of the largest online 3D printing innovation communities. Figure 1 shows the Thingiverse website's homepage. On Thingiverse, users can publish their ideas for the community to print, comment on, and even remix. Designers (idea publishers) upload the images of their 3D printable ideas together with one or more files required to print or remix the ideas. The Creative Commons licenses available to Thingiverse creators often allow for more or fewer limitations on the use and remixing of their ideas. Each idea contains a diverse variety of information, such as the creator, posted date, images, category, user comments, description, likes, and downloads. It also includes self-reporting information about the number of times other users have printed an idea (number of makes) and the number of times that the idea has been remixed from others (number of remixes). It also contains optional information about any sources which the idea was 'remixed' from.

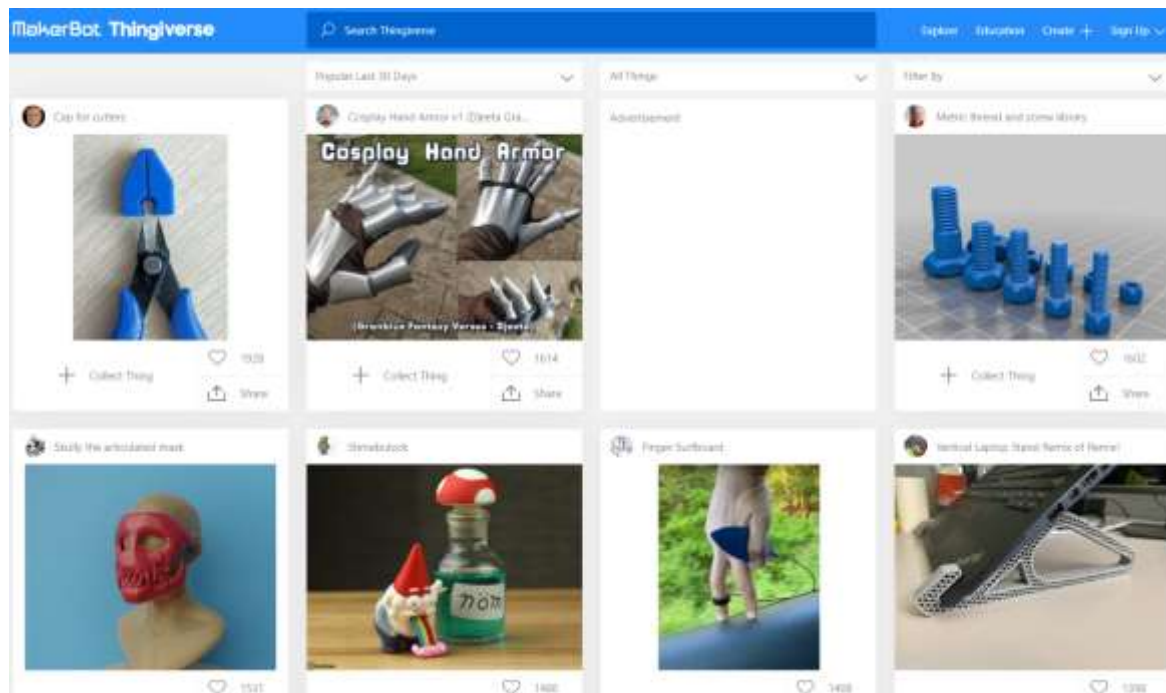


Figure 1: Thingiverse website's homepage

Data sampling

We collected only remixed ideas, including creator, posted date, user comments, category, images, text descriptions, files, likes, number of makes, and the origin information which include what ideas were remixed and its category. These data from Thingiverse were collected by using a custom-made web crawler implemented in python. The final dataset comprises 57,049 remixed ideas.

METHODOLOGY

Variables

Dependent variables

The dependent variable for the competing hypotheses is the *degree of innovation* of ideas. The number of forward citations of patents (i.e. the count of patents has been later patents) is frequently employed as a measure of the degree of innovation in research fields including knowledge-based innovation (Liu *et al.*, 2020). The forward citation number is a crucial innovative indicator that reveals how often patents spur subsequent patents (Liu *et al.*, 2020). Similarly, on Thingiverse, ideas can inspire the follow-up ideas which can be seen as the 'forward remixes.' Therefore, we used the *number of remixes* (i.e. how many ideas have been remixed by other ideas) as a proxy of the *degree of innovation*.

Additionally, we constructed another measurement of dependent variable, the *number of makes*. Ideas are generally accepted and implemented by people when the ideas are innovative (George & Zhou, 2007). We also considered the *number of makes* (i.e. the number of users who have actually printed the idea using a 3D printer) as a proxy of the *degree of innovation*. All dependent variables were log-transformed due to skewed distribution.

Independent variables

The first main independent variable is the *number of prior ideas*. We measured this by the *number of prior ideas* used for remixing. The prior ideas that have been combined for remixing are listed on Thingiverse.

The second main independent variable is a dummy variable representing whether the idea domains are transferred, denoted as *cross-boundary remix*. Each idea on Thingiverse has a category, which allows users to browse and search similar ideas. In this study, it is presupposed that if the category of an idea has changed, the domain of the idea has changed. Therefore, the *cross-boundary remix* is set to 1 if the category of the idea has changed (cross-boundary remix has occurred), and 0 otherwise.

We control for popularity indicators of ideas, such as likes and comments. The *likes* variable refers to the number of likes that indicate users' interest. The *comments* variable refers to the number of feedbacks of an idea. Then, we control for supplementary evidence of ideas such as the images and the idea length. *Images* variable refers to the number of images that provided by the idea publisher. The *idea length* variable refers to the count of words that were used to describe the idea. We control the complexity of ideas, such as files. The *files* variable refers to the number of files required to produce the idea to practice. In addition, the *published period*, which is calculated by the data collection date minus the idea published date, is used to control the period difference effect. The *category dummies* are used to control the intrinsic differences caused by different categories of ideas. Table 1 summarizes the descriptions of variables.

Table 1: Description and type of variables.

Variables	Description
Dependent variable	
<i>Number of Remixes</i>	The number of remixes that idea was remixed by other members
<i>Number of Makes</i>	The number of implementation that idea was implemented(printed) by other members
Independent variables	
<i>Number of Prior ideas</i>	The number of prior ideas used for remixing
<i>Cross-boundary remix</i>	1 if the idea remixed from different categories, 0 otherwise
Control variables	
<i>Images</i>	The number of images that provided by idea publisher
<i>Idea Length</i>	The number of words contained in the posted idea
<i>Files</i>	The number of files required to produce the idea
<i>Comments</i>	Number of comments on posted idea by members of the online community
<i>Likes</i>	The number of likes from members of the online community
<i>Category</i>	Category to which each idea belongs
<i>Published Period</i>	The period between the idea published date and the data collection date

Table 2: Descriptive statistics of continuous variables

	Num	Mean	SD	Min	Max
Number of Remixes	57,049	1.482	238.357	0	56,778
Number of Makes	57,049	0.425	7.572	0	1,309
Number of Prior ideas	57,049	1.092	0.639	1	27
Images	57,049	2.297	4.031	1	196
Idea Length	57,049	33.987	130.223	0	5,265
Files	57,049	1.767	6.208	0	1,278
Likes	57,049	32.286	370.336	0	51,761
Comments	57,049	1.290	14.886	0	2,185
Published Period	57,049	1,831.845	855.865	10	4,842

Descriptive Statistics and Correlations

Table 2 reports the descriptive statistics of all the variables. It is important to note that *cross-boundary remix* and *number of prior ideas* have a relatively low correlation in table 3. We produced variance inflation factors (VIFs), which measure the severity of multicollinearity in regression analyses, in order to test for possible issues of multicollinearity in our analyses. All VIFs were far below the 10 threshold (Cohen *et al.* 2014).

Empirical model

Since our dependent variables are continuous, we use the ordinary least squares estimator (OLS) to test our hypotheses. Equation (1) studies the impact of the *number of prior ideas* and *cross-boundary remix* on the *number of remixes* as a proxy of the *degree of innovation*. In equation (2), we used other dependent variables as mentioned in the dependent variables section. Therefore, we change the dependent variable, *number of remixes* to *number of makes*. The degree of innovation of remixed idea *i* can be written as

$$\text{Number of Remixes}_i = \alpha + \beta_1 (\text{Number of Prior ideas}_i) + \beta_2 (\text{Number of Prior ideas}_i)^2 + \beta_3 (\text{Cross-boundary remix}_i) + \gamma \text{Controls}_i + \varepsilon_i \quad (1)$$

$$\text{Number of Makes}_i = \alpha + \beta_1 (\text{Number of Prior ideas}_i) + \beta_2 (\text{Number of Prior ideas}_i)^2 + \beta_3 (\text{Cross-boundary remix}_i) + \gamma \text{Controls}_i + \varepsilon_i \quad (2)$$

$Controls_i$ represent a vector of control variables, including *images*, *idea length*, *files*, *comments*, *likes*, *published period*, and *category*. α is the constant term; ε_i is the error term; β_j can be interpreted as the change of degree of innovation when each variable change. γ is the vector of control variables' coefficient.

RESULTS

Main results

Table 4 presents the simple linear estimation results about the effect of the *number of prior ideas* on the *degree of innovation* and how the *cross-boundary remix* affects the *degree of innovation* of idea. Model (1) contains the *number of prior ideas* and its square term with control variables. Model (2) contains *cross-boundary remix* with control variables. Our main result is Model (3), which contains all independent variables. The adjusted R-squared value is 16.3% in Model (1) and it increases to 16.7%, and 16.8% in Model (2), and (3), respectively.

Table 3: Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Number of Remixes										
(2) Number of Makes	0.04	1								
(3) Number of Prior ideas	-0.00	0.02*	1							
(4) Cross-boundary remix	0.01*	0.06*	0.09*	1						
(5) Images	0.04*	0.08*	0.15*	0.27*	1					
(6) Idea Length	0.00	0.04*	0.63*	0.18*	0.25*	1				
(7) Files	0.02*	0.03*	0.07*	0.09*	0.49*	0.10*	1			
(8) Comments	0.09*	0.74*	0.04*	0.07*	0.20*	0.13*	0.10*	1		
(9) Likes	0.07*	0.38*	0.04*	0.09*	0.16*	0.08*	0.06*	0.47*	1	
(10) Period	0.01	0.01*	-0.02*	-0.26*	-0.17*	-0.06*	-0.07*	-0.02*	-0.01	1

* Denotes significance at the 1% level.

Table 4: OLS estimation results using first dependent variable

	Dependent variable: <i>Number of Remixes</i>		
	Model (1)	Model (2)	Model (3)
Number of Prior ideas	0.046*** (3.71)		0.046*** (3.83)
Number of Prior ideas ²	-0.003* (-2.56)		-0.003** (-2.58)
Cross-boundary remix		0.072*** (10.38)	0.072*** (10.28)
Images	0.011*** (8.46)	0.010*** (7.93)	0.010*** (7.88)
Idea Length	0.000 (1.87)	0.000*** (5.19)	0.000 (0.83)
Files	-0.006** (-2.95)	-0.000* (-2.33)	-0.000* (-2.30)
Comments	0.004*** (3.30)	0.004** (3.26)	0.004** (3.28)
Likes	0.000** (3.07)	0.000** (3.06)	0.000** (3.05)
Published Period	0.000*** (13.42)	0.000*** (15.06)	0.000*** (15.07)
Constant	-0.097*** (-7.36)	-0.073*** (-12.59)	-0.118*** (-9.04)
Category Dummies	Included	Included	Included
<i>N</i>	57,049	57,049	57,049
adj. <i>R</i> ²	0.163	0.167	0.168
<i>F</i>	99.36	121.3	109.5

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: OLS estimation results using second dependent variable

	Dependent variable: <i>Number of Makes</i>		
	Model (4)	Model (5)	Model (6)
Number of Prior ideas	0.041*** (3.88)		0.041*** (4.17)
Number of Prior ideas ²	-0.004*** (-4.93)		-0.004*** (-5.41)
Cross-boundary remix		0.163*** (17.10)	0.162*** (16.95)
Images	0.018*** (7.77)	0.016*** (7.39)	0.016*** (7.37)
Idea Length	0.000* (2.44)	0.000 (0.95)	0.000 (0.12)
Files	-0.003 (-1.56)	-0.003 (-1.52)	-0.002 (-1.52)
Comments	0.003** (3.22)	0.003** (3.19)	0.003** (3.20)
Likes	0.000** (3.12)	0.000** (3.13)	0.000** (3.12)
Published Period	0.000*** (14.42)	0.000*** (18.25)	0.000*** (18.31)
Constant	-0.077*** (-6.81)	-0.083*** (-11.84)	-0.122*** (-11.28)
Category Dummies	Included	Included	Included
<i>N</i>	57,049	57,049	57,049
adj. <i>R</i> ²	27.91%	29.48%	29.60%
<i>F</i>	155.5	232.7	208.3

p-values in parentheses

* *p* < 0.05, ** *p* < 0.01, *** *p* < 0.001

The *number of prior ideas* and the *degree of innovation of idea* have a significant inverted U-shaped relationship. (Model 3: $\beta_{\text{prior ideas}} = .046$, $p < 0.001$; $\beta_{\text{prior ideas}^2} = -.003$, $p < 0.05$); thus, Hypothesis 1 is supported. Using some proper prior idea has a positive effect on the *degree of innovation*, but using more ideas than a certain level has a negative effect on the *degree of innovation*.

Cross-boundary remix is positively correlated with the *degree of innovation* (Model 3: $\beta_{\text{cross-boundary remix}} = .072$, $p < 0.001$), so Hypothesis 2 is supported. Ideas remixed from the heterogeneous domain idea have a positive effect on the *degree of innovation*.

To validate our estimation results, in Tables 5, we further explore our hypotheses by using another dependent variable, *number of makes*. This alternative dependent variable is important because the degree of innovation has been measured as not only inspiring follow-up subsequent innovation but also measured innovation as idea's implementation. The results using alternative dependent variable show consistency with the main results. Model (4), (5), and (6) shows that the *number of prior ideas* and the *cross-boundary remix* significantly effect and have similar trend with main results on the *degree of innovation*.

CONCLUSIONS

Discussion of Findings

This study aims to investigate the impact of cross-boundary remixes and the number of prior ideas on the degree of inventiveness of ideas in OICs. Our results reveal that there is an inverted U-shaped relationship between the number of prior ideas used for remixing and the degree of innovation of the idea. The more prior ideas used for remixing, the more innovation of the idea increases, but after a certain point the degree of innovation decreases. We also find that cross-boundary remix increases the idea's degree of innovation. Ideas that were remixed from different domains are more innovative than ideas that were remixed from the same domain. These results showed the same phenomena for two independent variables (*number of remixes* and *number of makes*).

Theoretical Implications

We suggest three theoretical contributions. First, our study found how remixing creates more innovative ideas in the OICs. Since there are few studies that have confirmed remixing on online platforms, this study can be said to be a new attempt,

unlike other studies. Second, our study collected data through a new platform called Thingiverse, one of the OICs. This suggests that OICs with new characteristics continue to appear in our society, and shows that platform-specific characteristics are prominent. As a result, this study can be said to be a timely study for platform changes. Third, the results of this study show the form of an inverted U-shaped, and it was found that too much remixing reduces the number of ideas generated. This provides implications that too much innovation within the OICs has adverse effects.

Managerial Implications

From the perspective of channel operators who operate OICs, they can understand how to create efficient ideas. First, in the case of channels that do not use remixing as a category among OICs, it is possible to consider expanding channel operations by classifying remixing into categories. This improves users' innovation and helps them share new ideas. Second, as a result of this study, since an inverted U-shaped has occurred, it is important to understand where the OICs is refracted. Through these inflection points, various countermeasures such as not showing the remix number in detail can be discussed. Third, since innovation helps create ideas, it can be considered to add categories that can increase innovation. In this paper, innovation is viewed as a remix, so other factors besides remixing can be introduced.

Limitations and Future Research

The study that we conducted is subject to a few limitations. First, we examined only one OICs. It is possible that other OICs will bring results that contradict our findings. Therefore, it will be limited to generalizing our findings. Second, we gathered our dataset at one particular moment in time, representing a snapshot of a vibrant platform. For example, we simply know the number of makes at a given point in time. There is no record of when a download occurred. Therefore, our dataset does not provide an explanation of the complex causality involved in innovation. Third, our study only relies on data from the OICs itself. Our study did not include interviews with users and consideration of their motivations. It would be helpful to comprehend their motivation regarding the effect of the number of recombined prior ideas and cross-boundary remix on the degree of innovation of the idea in OICs.

Thus, we recommend that future studies consider various OICs as a dataset. The more dataset from various platforms enhanced the validity of generalizing the research findings. Moreover, to overcome the nature of the dataset as a snapshot and to gain the causality involved in innovation, future research should consider interviews with users. It would help to find various factors affecting the degree of innovation of ideas in OICs.

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The value of additional reviews in reputation systems: Evidence from a car review platform

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ABSTRACT

Online reviews, especially additional reviews, have become an important channel for consumers to obtain information about product quality. Based on review data obtained from “AutoHome”, which is a most popular car review platform in China, this study explores the influence of additional review function on the initial reviews from both the reader and reviewer levels. At the reader-level, the introduction of the additional review function improves readers’ perceived usefulness of the reviews. At the reviewer-level, it can drive reviewers to write more initial reviews. In general, the introduction of such a function can be regarded as an improvement of the existing review mechanism. The findings of this study can not only enrich the research on online word-of-mouth, but also provide valuable reference for related practitioners.

Keywords: Online reviews, additional reviews, natural experiment, review usefulness.

INTRODUCTION

With the development of E-commerce, online reviews are becoming increasingly more important for both businesses and consumers. For the former, online reviews are an important means for them to influence the consumer decision; and for the latter, they are also an important channel to understand the products (Ho-Dac, Carson, & Moore, 2013). In order to ensure the quality of online reviews, major E-commerce platforms have introduced the function of additional reviews. Different from initial reviews, additional reviews require more effort from reviewers, suggesting that the reviewers are responsible, so readers’ perceived usefulness will be higher (Jonas, Diehl, & Bromer, 1997). Once the additional review was released, it has become a research hotspot.

Previous studies have shown that additional reviews can impact users’ behavior (Akhtar et al., 2019; Chen, Yan, Xie, Zhang, & Chen, 2019). Consumers’ trust is related to the similarity between the additional reviews and the initial reviews (Akhtar et al., 2019). The emotional changes of additional reviews can also affect consumer’s purchase intention (Chen et al., 2019). However, previous studies have not explored the changes of initial reviews after the introduction of additional reviews, and how these changes may affect user behavior. At the reader-level, the introduction of additional reviews may change the perceived usefulness of the initial reviews, and then may change the amount of reading and the amount of reader comments. At the reviewer-level, the additional reviews may change the reviewers’ enthusiasm for the initial reviews. Initial reviews are an important kind of online reviews, and they also have important effects on consumers (Houser & Wooders, 2006). Therefore, this paper will discuss the influence of additional reviews on the initial reviews at these two levels.

“AutoHome” is the most viewed car online word-of-mouth platform in China (www.autohome.com.cn). It introduced the function of additional reviews in July 2014. In order to implement the natural experiment, we collect all of the online reviews on “AutoHome” published in 2014. We organize them into panel data and conduct natural experiments at both the reader-level and the reviewer-level. The results show that the introduction of additional reviews has an impact on the user behavior in terms of initial reviews. At the reader-level, additional reviews can increase the perceived usefulness of the initial reviews. At the reviewer-level, additional reviews can increase reviews’ enthusiasm for the initial reviews and make them more objective.

The remainder of this paper is organized as follows. Section 2 analyzes the research theories and infers the hypotheses according to the existing literature. We introduce the methodology of this study, which includes the process of data collection and the establishment of the models in Section 3. In Section 4, we introduce the research results of this study. At last, we summarize the contributions, limitations and future work directions in Section 5.

THEORETICAL BACKGROUND AND HYPOTHESES

Theoretical Background

Online reviews

Online reviews refer to online consumers who have completed the purchase behavior to exchange information about product quality and experience (Chatterjee, 2001). Previous studies on online reviews have focused on the usefulness of online reviews,

the impact of online reviews on consumer behavior, and the impact on the characteristics of consumers (Lamb, Cai, & McKenna, 2020). Using hotel review data, Huang finds that when the reviews are based on narrative (unstructured), the positive expressions will enhance the usefulness of the reviews; however, when the reviews are based on list (structured), the negative expressions will enhance the usefulness of the reviews (Huang, Chang, Bilgihan, & Okumus, 2020). Ghose found that the subjectivity of review text has a negative impact on the usefulness of review, and the readability has a positive impact on the usefulness of review (Ghose & Ipeirotis, 2011). Based on the theories of “use and satisfaction” (U&G) and “consumer culture” (CCT), Tran verifies the positive impact of online reviews on purchase intention, and confirms the moderating role of cosmopolitanism (Tran, 2020). By using review data of “surprise box”, Xu finds that consumers tend to publish more reviews with extreme emotions, and the impact is more significant for extreme negative emotions (Xu, 2020).

Additional reviews

Additional reviews mean that consumers comment about the same product again on the basis of the initial reviews. Chen finds that the order of contradictory reviews and product participation can significantly affect consumers' purchase intention, and the influence of product participation on consumers' purchase intention is different with diverse contradictory order (Chen et al., 2019). By using the real review data of hotels in China, Akhtar finds that the more similar between the content of the additional reviews and initial reviews, the more reviewers can earn the trust of other consumers (Akhtar et al., 2019). Consistent with the above studies, our study is also focused on additional reviews. We will put forward our hypotheses in the following section.

Hypotheses Development

The effects of additional review function on readers

Chatterjee defines perceived usefulness as the reader's perception that reviews can reduce their own information gap (Chatterjee, 2001). Additional reviews are the supplements and revisions of initial reviews, and need reviewers to make more efforts (Jonas et al., 1997). The more efforts the reviewer makes, the more serious he/she will be while writing a review (Duan, Gu, & Whinston, 2008). Still further, the more serious he/she will be while writing a review, which shows the responsible attitude of the reviewer, so the higher the perceived usefulness of the reader. Accordingly, we propose the following hypothesis.

H1: The perceived usefulness of reviews increases after the additional review function is launched.

According to the Information Adoption Model (IAM), which is the determinant of consumers, adoption of online reviews depend on the perceived usefulness of online reviews, while the main factors influencing the perceived usefulness of online reviews are information quality and source credibility (Sussman & Siegal, 2003). In other words, consumers are more likely to adopt reviews with higher perceived usefulness than the lower ones. The content of additional reviews usually contains more information about the product and the deeper understanding of the product as time goes by, thus, consumers will find additional reviews more useful (Pee, 2016). That is to say, consumers are more inclined to read the additional reviews which are more helpful rather than the initial reviews which are less useful. Therefore, this study argues that the introduction of additional reviews may reduce the view number of initial reviews. Based on the above arguments, we propose H2.

H2: The view number of an initial review decreases after the additional review function is launched.

The Elaboration Likelihood Model (ELM) points out that when consumers purchase products with high involvement, they tend to put more energy into searching for products related information, and will conduct fine evaluation on the information content (Hong, 2015). Relatively, the investment of cars is expensive for most families, so consumers' purchase decision-making about cars is also more serious. Therefore, the car has a high level of involvement in products. Before buying a car, consumers will collect as much information as possible, and process the collected information. Other readers' comments are also a way for users to obtain the information. After the launch of additional review function, reviewers are willing to make more efforts. Then they are more likely to respond to readers' questions. This means that readers are more likely to get the information they truly want through the readers' comments. It will increase the enthusiasm of readers to comment. Therefore, we put forward H3.

H3: The number of readers' comments increases after the additional review function is launched.

The effects of additional review function on reviewers

Previous studies have found that the motivations of comment can be roughly divided into two aspects: (1) the motivation of positive reviews, which includes helping others, producing involvement, self-improvement, helping businesses, sharing the emotional needs; (2) the motivation of negative reviews, which includes helping others and payback (Sundaram, Mitra, & Webster, 1998). Obviously, whether it is a positive review or a negative review, emotion is crucial to motivation, especially for the experiential products, such as cars. Additional review is an important channel to express emotions, and reviewers also aim to write reviews to share their feelings. However, for the platform of “AutoHome”, the prerequisite for making an additional review is to make an initial review. Therefore, with the introduction of additional reviews, the amount of initial reviews may also increase. For this reason, this study puts forward H4.

H4: The number of initial reviews increases after the additional review function is launched.

Nelson divides products into experience products and search products according to whether users need to learn the characteristics of products through experience (Nelson, 1974). The reviews on “AutoHome” are structured, and the reviewers can only comment within a given framework. There are different attributes specified in the framework. Thus, we can also divide the attributes in the framework into observational attributes and experiential attributes according to whether we need

experience to know the attribute. The initial reviews are more about the description of observational attributes, while the additional reviews are more about the description of experiential attributes. Therefore, after the introduction of additional reviews, the initial reviews will reduce the number of words of experiential attributes, however, may improve the user's participation and increase the number of words of observational attributes. Yet it is not clear which of these two changes has a greater impact; that is, how the number of words changes is uncertain. Thus, we put forward the following two opposing hypotheses:

H5a: The length of an initial review increases after the additional review function is launched.

H5b: The length of an initial review decreases after the additional review function is launched.

Self-enhancement Theory is one of the most important motivations affecting word-of-mouth communication (De Angelis, Bonezzi, Peluso, Rucker, & Costabile, 2012). According to the self-enhancement theory, reviewers tend to make consistent attitude on the same product in order to maintain their public reputation (Berger & Schwartz, 2011). Before the introduction of additional reviews, reviewers can only comment once. And they tend to comment immediately after receiving the car. However, the joy when they just received the product and their lack of understanding of the product make them give a high score in the rating. After the introduction of the additional review function, reviewers have the opportunity to comment twice. In order to make the emotional attitudes of the two reviews tend to be the same, at least not in the opposite state, reviewers will try their best to keep objective and neutral when making the initial rating. Therefore, the initial ratings will be lower. For this reason, this study puts forward hypothesis H6.

H6: The rating of an initial review decreases after the additional review function is launched.

Figure 1 summarizes the overall research framework of this paper, covering research objects, theories, hypotheses and variables.

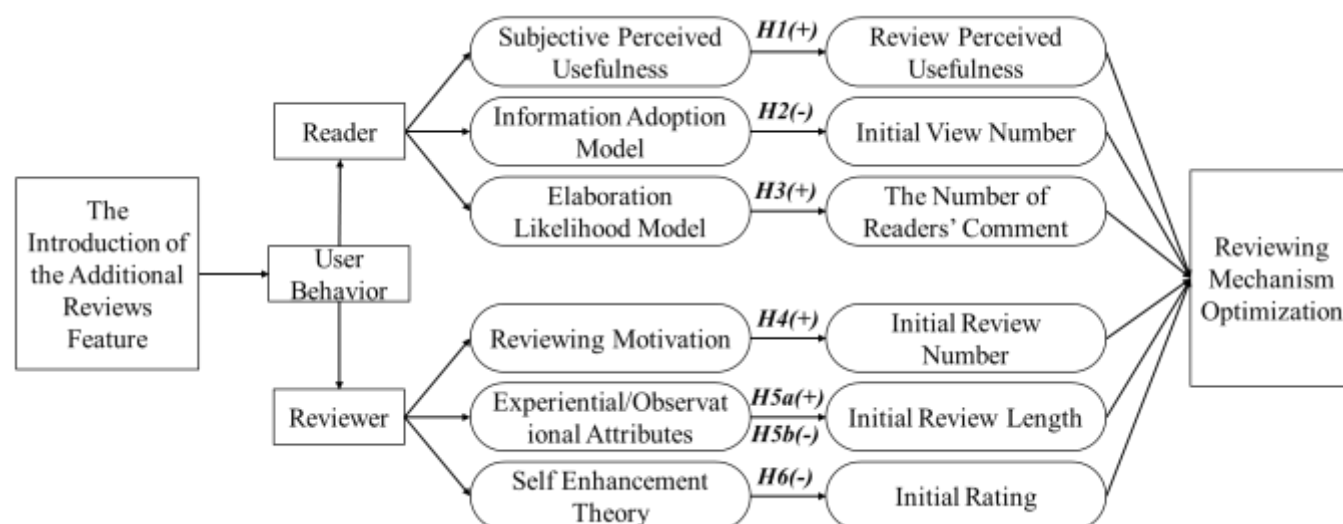


Figure 1: Research Design

METHODOLOGY

Data Collection

“AutoHome” is the most popular auto platform in China. “AutoHome” introduced the function of additional reviews in July 8, 2014. In order to conduct a natural experiment, we collected the reviews and related data posted in 2014 from “AutoHome”. If the time window is too short, the results may not show up; furthermore, if the time window is too long, it will dilute the impact of this event. Therefore, we selected 14 weeks as the time window. Using Python crawler program, we collected the data between 7 weeks before and after the introduction of the function of additional reviews (from May 20 to August 26, 2014). We labelled each car (represented by an ID). All the reviews of the selected cars in the selected time window, as well as the pageview number, review likes count, reader comments count, initial rating, car price, reviewer level and other information are crawled. In order to ensure that the natural experiment can eliminate other interference, we excluded those cars which only have reviews before or after the introduction of the function. Finally, we collected a total of 24,621 reviews involving 392 types of cars. The time window is numbered by week (-7 to 7). Week-7 through week-1 represent the weeks before the introduction of the function, and week1 through week7 represent the weeks after it. Taking “ID” as the i of panel data and “week” as the t of panel data. We averaged the weekly data, and then sorted the data into panel data with $i = 392$ and $t = 14$. After removing the missing values, we finally collected 3,972 panel data.

Variables and Models

In order to facilitate the collation of panel data, we take the week as the dimension of all variables and get the average value of the week. We present all the variables and their measurement in Table 1.

Table 1: Variable Description

Variable Type	Variable	Description	Note
Dependent variable	$useful_visit_{it}$	usefulness (review likes count) \div visits count	the average value of the week
	$comment_visit_{it}$	comments count \div visits count	
	$ln_visitcount_{it}$	the logarithm of pageview number	
Independent variable	$addreview_t$	dummy variable indicates whether period t is after the event	
Control variable	ln_price_{it}	the logarithm of car price	the average value of the week
	$reviewer_level_{it}$	reviewer level	
	$ln_visitcount_{it}$	the logarithm of pageview number	

We use $useful_visit_{it}$ and $comment_visit_{it}$ representing the perceived usefulness (quantify by the likes count) per unit amount of visit and the number of reader comments per unit amount of visit, respectively. $addreview_t$ is a dummy variable, which 0 represents before the introduction of additional reviews and 1 represents after the introduction of additional reviews. ln_price_{it} is the logarithm of car price, and $reviewer_level_{it}$ represents reviewer level. These two variables are used as the control variables to control other factors that may affect dependent variables. $ln_visitcount_{it}$ represents the logarithm of pageview. We believe that, although 1/10 and 100/1000 are both equal to 0.1, the meanings they represent are quite different. In this study, we discuss the absolute, not the relativity. So, Model (1) and (3) add the control variable $ln_visitcount_{it}$ to control the magnitude of the dependent variable.

Then, according to the hypotheses $H1-H3$, the reader-level models are proposed as:

$$useful_visit_{it} = \beta_0 + \beta_1 addreview_t + \beta_2 ln_price_{it} + \beta_3 reviewer_level_{it} + \beta_4 ln_visitcount_{it} + \varepsilon_{it} \quad (1)$$

$$ln_visitcount_{it} = \beta_0 + \beta_1 addreview_t + \beta_2 ln_price_{it} + \beta_3 reviewer_level_{it} + \varepsilon_{it} \quad (2)$$

$$comment_visit_{it} = \beta_0 + \beta_1 addreview_t + \beta_2 ln_price_{it} + \beta_3 reviewer_level_{it} + \beta_4 ln_visitcount_{it} + \varepsilon_{it} \quad (3)$$

Moreover, num_{it} represents the total number of reviews per week. ln_len_{it} is used to measure the number of words, and $star_{it}$ represents the initial rating. The other variables in Model (4) through (6) are consistent with Model (1) through (3).

$$num_{it} = \beta_0 + \beta_1 addreview_t + \beta_2 ln_price_{it} + \beta_3 reviewer_level_{it} + \varepsilon_{it} \quad (4)$$

$$ln_len_{it} = \beta_0 + \beta_1 addreview_t + \beta_2 ln_price_{it} + \beta_3 reviewer_level_{it} + \varepsilon_{it} \quad (5)$$

$$star_{it} = \beta_0 + \beta_1 addreview_t + \beta_2 ln_price_{it} + \beta_3 reviewer_level_{it} + \varepsilon_{it} \quad (6)$$

METHODOLOGY

The Results of the Reader-Level

Table 2 shows the descriptive statistical result of the reader-level variables. There should be 3,972 pieces of panel data in 14 weeks, but the observations are not exactly equal due to the missing value of some models and some variables.

Table 3 shows the correlation test of the variables of the reader-level. It can be found that the correlation coefficients between variables are less than 0.5. And the last row of Table 3 shows the variance inflation factor values (VIF). We can see that all the VIF values are less than 5. Therefore, there is no multicollinearity, so that the selected variables can be further analyzed.

In order to test the hypotheses of reader-level, we conduct the fixed effects regression. The results of regression are shown in Table 4. It can be found that $addreview_t$ is significant ($p < 0.01$) in Model (1) and (2). Furthermore, after the introduction of additional reviews, the perceived usefulness ($useful_visit_{it}$) increases while the pageview ($ln_visitcount_{it}$) decreases. And the regression results of readers' comments are not significant. Therefore, $H1$ and $H2$ are supported, while $H3$ is rejected. The number of readers' comments does not have significant improvement. Thus, additional reviews probably make people lazy, and readers are more willing to wait for additional reviews than to participate in reviews.

Table 2: Descriptive Statistics of Reader-Level

Variable	Obs#	Mean	Std. Dev.	Min	Max
$ln_visitcount_{it}$	3,972	9.006	1.5713	5.2149	14.9800
$useful_visit_{it}$	3,898	0.0009	0.0011	0	0.0173
$comment_visit_{it}$	3,911	0.0001	0.0002	0	0.0054
$addreview_t$	3,972	0.4615	0.4986	0	1
ln_price_{it}	3,972	2.6370	0.8659	0.4054	6.8046
$reviewer_level_{it}$	3,972	0.9775	0.6740	0	3

Table 3: Correlation Matrix and VIF Values of Reader-Level

	(1)	(2)	(3)	(4)	(5)	(6)
(1) <i>useful_visit_{it}</i>	1					
(2) <i>comment_visit_{it}</i>	0.1504	1				
(3) <i>addreview_t</i>	0.0643	0.0239	1			
(4) <i>ln_price_{it}</i>	-0.1489	-0.0887	0.0032	1		
(5) <i>reviewer_level_{it}</i>	-0.0286	-0.0516	-0.0283	0.0385	1	
(6) <i>ln_visitcount_{it}</i>	-0.2094	-0.1376	-0.0420	0.3154	-0.0034	1
VIF	1.0500	1.0700	1.0800	1.0400	1.0800	1.0200

Table 4: Regression Results of Reader-Level

	(1) <i>useful_visit_{it}</i>	(2) <i>ln_visitcount_{it}</i>	(3) <i>comment_visit_{it}</i>
<i>addreview_t</i>	0.0110** (0.0034)	-0.1411*** (0.0392)	0.0548 (0.0665)
<i>ln_price_{it}</i>	0.0047 (0.0087)	0.0372 (0.0793)	-0.1053 (0.0780)
<i>reviewer_level_{it}</i>	-0.0001 (0.0029)	0.0993** (0.0316)	-0.0963 (0.0666)
<i>ln_visitcount_{it}</i>	-0.0152*** (0.0019)		-0.2408*** (0.0451)
<i>_cons</i>	0.2069*** (0.0325)	8.885*** (0.2125)	3.258*** (0.5245)
<i>Obs#</i>	3,898	3,972	3,911
<i>Adj. R²</i>	0.0312	0.0363	0.0393

Notes: Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The Results of the Reviewer-Level

Table 5 shows the descriptive statistics of the variables of reviewer-level. This study does not fill in the missing value, therefore, in the descriptive statistics, the minimum number of reviews is 1 instead of 0.

Table 6 shows the correlation test results of the variables of the reviewer-level and the VIF values. Obviously, as shown in Table 6, the variables of reviewer-level can be further analyzed.

In order to test the hypotheses of reviewer-level, we conduct the fixed effects regression on Model (4) through (6), and the results are shown in Table 7. It can be seen that *addreview_t* is significant ($p < 0.001$) in Model (4) and (6), in which *num_{it}* is significantly increased and *star_{it}* is significantly decreased, however the regression result of *ln_len_{it}* is not significant. Therefore, the hypotheses *H4* and *H6* are supported and hypotheses *H5a* and *H5b* are rejected. There are two possible explanations for no significant change in the length of reviews. First, according to our hypothesis, the number of words for the observational attribute has increased, and meanwhile, the number of words for the experiential attribute has decreased. On the whole, the changes of the two may offset each other. Second, most users pursue a sense of participation rather than identity, therefore the online additional reviews will not change their efforts, that is to say, the number of words in the two attributes has not changed at all. However, it is not clear which of these explanations is correct.

Table 5: Descriptive Statistics of Reviewer-Level

Variable	Obs#	Mean	Std. Dev.	Min	Max
<i>num_{it}</i>	3,972	5.2181	6.2264	1	79
<i>ln_len_{it}</i>	3,935	5.9301	0.5067	2.8332	7.6353
<i>star_{it}</i>	3,951	4.1741	0.0002	1	5
<i>addreview_t</i>	3,972	0.4615	0.4986	0	1
<i>ln_price_{it}</i>	3,972	2.6370	0.8659	0.4054	6.8046
<i>reviewer_level_{it}</i>	3,972	0.9775	0.6744	0	3

Table 6: Correlation Matrix and VIF Values of Reviewer-Level

	(1)	(2)	(3)	(4)	(5)	(6)
(1) <i>num_{it}</i>	1					
(2) <i>star_{it}</i>	0.1698	1				
(3) <i>ln_len_{it}</i>	0.1864	0.1188	1			
(4) <i>addreview_t</i>	0.0652	-0.0359	0.0072	1		
(5) <i>ln_price_{it}</i>	-0.0026	0.2788	-0.0531	0.0032	1	
(6) <i>reviewer_level_{it}</i>	-0.0218	-0.0322	0.0806	-0.0283	0.0385	1

	(1)	(2)	(3)	(4)	(5)	(6)
VIF	1.0500	1.0200	1.0500	1.0800	1.0400	1.0700

Table 7: Regression Results of Reviewer-Level

	(4) <i>num_{it}</i>	(5) <i>ln_len_{it}</i>	(6) <i>star_{it}</i>
<i>addreview_t</i>	0.8091*** (0.1765)	0.0026 (0.1519)	-0.0363*** (0.0117)
<i>ln_price_{it}</i>	0.3054 (0.2059)	0.0252 (0.0231)	0.0299 (0.0164)
<i>reviewer_level_{it}</i>	-0.1156 (0.0630)	-0.0458** (0.0166)	0.0131 (0.0123)
<i>_cons</i>	4.1386*** (0.5501)	5.8181*** (0.0632)	4.101*** (0.0470)
<i>Obs#</i>	3,939	3,935	3,951
<i>Adj. R²</i>	0.0001	0.0003	0.1734

Notes: Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

ROBUSTNESS CHECK

In order to verify the robustness of this study, the different time windows of 16 weeks and 12 weeks were selected to further test the above variables. The test results of reader-level at 16 weeks and 12 weeks are shown in Table 8. It can be found that the results remain consistent with Table 4. For example, the regression results of 16 weeks and 12 weeks of usefulness are significantly increased, which are consistent with 14 weeks. Therefore, the results of reader-level have passed the robustness check.

Similarly, this paper uses the same time windows to test the robustness of the variables of reviewer-level, and the results are shown in Table 9. It can be seen that, for the same dependent variable, the regression results of 16 weeks and 12 weeks are basically identical, which are consistent with the regression results of 14 weeks.

Table 8: Robustness Check of Different Time Windows at Reader-Level

	(1) <i>useful_visit_{it}</i>		(2) <i>ln_visitcount_{it}</i>		(3) <i>comment_visit_{it}</i>	
	<i>16weeks</i>	<i>12weeks</i>	<i>16weeks</i>	<i>12weeks</i>	<i>16weeks</i>	<i>12weeks</i>
<i>addreview_t</i>	0.1225*** (0.0033)	0.0118*** (0.0035)	-0.1599** (0.0372)	-0.1283** (0.0424)	0.0638 (0.0702)	0.0494 (0.0606)
<i>ln_price_{it}</i>	0.0052 (0.0074)	0.0083 (0.0109)	0.0195 (0.0680)	-0.0119 (0.0690)	-0.0561 (0.0913)	-0.1485 (0.0962)
<i>reviewer_level_{it}</i>	-0.0003 (0.0029)	-0.0005 (0.0030)	0.1047** (0.0304)	0.0998** (0.0351)	-0.0190 (0.0794)	-0.1154 (0.0788)
<i>ln_visitcount_{it}</i>	-0.0152** (0.0017)	-0.0154** (0.0021)			-0.2445*** (0.0451)	-0.2444*** (0.0508)
<i>_cons</i>	0.2057*** (0.0284)	0.1990*** (0.0383)	8.9152*** (0.1833)	9.040*** (0.1877)	3.096*** (0.5229)	3.4225*** (0.5890)
<i>Obs#</i>	4,414	3,339	4,428	3,353	4,427	3,352
<i>Adj. R²</i>	0.0334	0.0122	0.0015	0.0064	0.0465	0.0376

Notes: Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9: Robustness Check of Different Time Windows at Reviewer-Level

	(4) <i>num_{it}</i>		(5) <i>ln_len_{it}</i>		(6) <i>star_{it}</i>	
	<i>16weeks</i>	<i>12weeks</i>	<i>16weeks</i>	<i>12weeks</i>	<i>16weeks</i>	<i>12weeks</i>
<i>addreview_t</i>	0.6245*** (0.1775)	0.4256* (0.1668)	0.0025 (0.0148)	0.0195 (0.0166)	-0.0315** (0.0110)	-0.0371** (0.0123)
<i>ln_price_{it}</i>	0.3737 (0.1999)	0.3332 (0.2662)	0.0314 (0.0205)	0.0019 (0.0226)	0.0223 (0.0154)	0.0324 (0.0177)
<i>reviewer_level_{it}</i>	-0.1081 (0.0591)	-0.1061 (0.0673)	0.0549*** (0.0159)	0.0463** (0.0177)	0.0159 (0.0112)	0.0099 (0.0132)
<i>_cons</i>	4.0448*** (0.5400)	4.1618*** (0.7014)	5.7878*** (0.0573)	5.8823*** (0.0621)	4.1153*** (0.0431)	4.1024*** (0.0493)
<i>Obs#</i>	4,462	3,371	4,453	3,368	4,474	3,383
<i>Adj. R²</i>	0.0001	0.0001	0.0001	0.0002	0.1645	0.1698

Notes: Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

CONCLUSION AND DISCUSSIONS

To some extent, the introduction of additional reviews is the inevitable product of the development of online reviews, which has an impact on the initial reviews. On the basis of previous studies, this study aims to explore the influence of additional review function on initial reviews from the reader- and reviewer-level with the data from “AutoHome”. At the reader-level, additional reviews can improve the perceived usefulness of the initial reviews, and can decrease the view number of initial reviews. At the reviewer-level, additional reviews can increase the number of initial reviews and lower the initial rating, making the initial reviews more objective. However, the length of initial reviews has not changed.

In general, this study enriches the research on online word-of-mouth and provides a new research direction for online reviews. Our study finds that additional reviews can affect user behavior in terms of initial reviews and it can also improve the overall appraisal. The findings of this paper also have some practical implications. Consumers will be advised to read reviews with additional reviews because that's usually more useful. And the platform can introduce the function of additional reviews to improve the comment mechanism.

There are still several limitations in this study. First, due to the reviews' characteristics of “AutoHome” platform, the results of this study are only applicable to E-commerce platforms with structured reviews. Second, it is not clear which of the hypotheses is the reason why the length of reviews has not changed significantly. Third, the research perspective has not been considered comprehensively, and the future research may consider a wider range of the influencing factors.

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Understanding perceived shopping effectiveness with omnichannel: A MOA theory perspective

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ABSTRACT

Customers' shopping effectiveness is a critical factor in encouraging customers to stay with the firms, the knowledge regarding how to provide shopping effectiveness in an omnichannel retailing environment remains underexplored. Thus, this study draws on Motivation-Opportunity-Ability theory (MOA) and examines MOA factors affecting customers' perceived shopping effectiveness, which in turn influences customers' omnichannel usage continuance intention. The expected findings may suggest that the opportunity factor, channel integration quality encompassing channel-service configuration, content consistency, process consistency, and assurance quality, positively influences customers' perceived shopping effectiveness. Furthermore, the motivation factors such as relative advantage, perceived ease of use, personalized incentives, flow, and enjoyment, have positive effects on customers' perceived shopping effectiveness. In addition, ability factors encompassing technology readiness and self efficacy are expected to influence perceived shopping effectiveness. As a result, perceived shopping effectiveness positively influences omnichannel usage continuance intention. These findings enhance the literature on the shopping values and channel integration quality in an omnichannel retailing environment. These findings also offer insightful implications for omnichannel retailers in terms of creating and managing customers' shopping effectiveness in the post-COVID period.

Keywords: Omnichannel, shopping effectiveness, MOA, channel integration quality, personalized incentives.

INTRODUCTION

The proliferation of digital technologies leads to an increasing number of companies implementing an omni-channel retailing strategy to enhance customer shopping experiences (Adivar et al., 2019). Omnichannel retailing refers to retailing that involves channel integration quality for the purpose of creating a seamless shopping experience for customers, regardless of the channel or purchasing process stage, which lies at the heart of omnichannel retailing (Cummins et al., 2016). These days, customers no longer purchase only in-store or online; instead, they shop across channels. They use various channels such as physical stores, websites, direct mail and catalogs, social media sites, review sites, call centers, mobile devices, kiosks, home services, networked appliances, so on and so forth to complete a single purchase. For example, they search for information in one channel, and complete the purchase in another (Asare et al., 2022). Furthermore, the move toward shopping with omnichannel platforms has created opportunities for omnichannel retailers to improve the holistic consumer shopping experience by adding more fun, unique incentives, and higher shopping efficacy (Alizila, 2018). For example, omnichannel allows consumers to experience a shopping environment within a physical store, such as exploring product information that can only be found through digital channels with the added benefit of touching, feeling, and seeing how the products function, sharing information with friends, or receiving social network comments from friends. After leaving the store, they can still keep updated with new product information and sales events within the omnichannel platform. As a result, consumers can enjoy multiple benefits such as increased efficiency, monetary benefits, novelty, and enjoyment by a greatly enhanced consumer shopping process with omnichannel. In addition, omnichannel can facilitate personalized collaborative activities with friends to earn rewards, offering individualized shopping services, push notifications, and rewards, generating unique consumer shopping experience (Lemon & Verhoef, 2016). IKEA (UK) reported that after making its products pretty much accessible across retailing channels, customers increasingly used both online and offline channels to complete their purchasing journey, which resulted in a 31% rise in online sales (Rigby, 2016). International Data Corporation (IDC) found that customers using both online and physical channels have 30% higher lifetime value than those purchasing from a single channel. Many managers have cited the omni-channel strategy as a top business priority (Shen et al., 2018), as it can increase per order value by 13% on average and produce 90% higher customer retention rates than a single-channel strategy (Collins, 2019). In China, 85% of apparel shoppers now engage with omnichannel services to make purchases, up from 80% in 2017 (McKinsey Digital, 2019). Furthermore, COVID-19 pandemic prompts 90% of younger customers to continue adopting omnichannel services (Oliver Wyman, 2020). In Vietnam, consumers have shifted towards omni-channel purchasing behaviours in the post-COVID period, resulting in more than 50 per cent of Vietnamese consumers have reduced their frequency of visits to supermarkets, grocery stores and wet markets, while 25 per cent of them have increased online shopping (Vietnamnet, 2020).

With huge advantages of omnichannel, it is supposed that omnichannel retailing can be a promising strategy for firms to increase the customers' shopping effectiveness. However, limited research has explored the customer perception of shopping effectiveness with omnichannel. As it is the main contribution, this study explores the factors that influence the customer perception of shopping effectiveness with omnichannel. More specifically, the present study uses motivation, opportunity, and ability (MOA) framework (MacInnis et al., 1991) to examine the factors that determine customers' perception of shopping

effectiveness with omnichannel. In doing so, this study investigates the role of motivations (relative advantage, perceived ease of use, flow, and enjoyment, personalized incentives), opportunity (channel integration quality), and ability (self-efficacy, technology readiness) on shoppers' perception of shopping effectiveness with omnichannel, which in turn, influence their omnichannel usage continuance intention.

THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT

Motivation-Opportunity-Ability (MOA) Theory

MOA theory (MacInnis et al., 1991) explains that consumer behaviour is affected by motivation, opportunity, and ability. In other words, consumer behaviour is considered as a function of the consumer's willingness to perform a particular behaviour (motivation) combined with his or her internal capability (ability) and contextual factors (opportunity). Thus, consumers' behaviour can be proactively managed by controlling the levels of motivation, opportunity, and ability variables. For this reason, the MOA theory was chosen to examine customer adoption of omnichannel in this study.

Although the omnichannel retailing offers many benefits for customers, a lack of knowledge of its adoption drivers may cause retailers to struggle to manage it effectively. Thus, an understanding of the factors that drive customers to perceive shopping effectiveness of omnichannel is essential for retailers in providing insights into customers' adoption of omnichannel. The MOA framework (MacInnis et al., 1991) is used to theoretically identify and hypothesize variables that influence customers' perception of shopping effectiveness toward omnichannel. The MOA framework is a well-established theory, which has been applied to explain behaviours in consumers, employees, and salespeople (Sabnis et al., 2013). This theory assumes that if motivation, ability, and opportunity can each present a potential determinant of customers' shopping effectiveness with omnichannel, then retailers can identify specific driving forces and employ appropriate strategies for successful implementation of omnichannel. Consistent with existing research (e.g., Cui et al., 2020), this study identifies variables that are relevant for MOA factors for customer adoption of omnichannel. This study used this perspective as using MOA variables allows a more careful examination as well as considers context-specific factors influencing the customer perception of shopping effectiveness, which in turn, affects omnichannel usage continuance intention. Particularly, it is hypothesised that motivation variables encompassing relative advantage, perceived ease of use, personalized incentives, flow, and enjoyment. Opportunity variables including dimensions of channel integration quality, and ability variables including technology readiness and self-efficacy directly impact perceived shopping effectiveness. Perceived shopping effectiveness is defined in this study as the extent to which consumers perceive using omnichannel to improve their overall shopping experience (Roy et al., 2017). Consequently, perceived shopping effectiveness affects omnichannel usage continuance intention referring to the extent to which a customer wishes to continue to use omnichannel for shopping (Gao et al., 2021). Figure 1 presents the conceptual framework of this study.

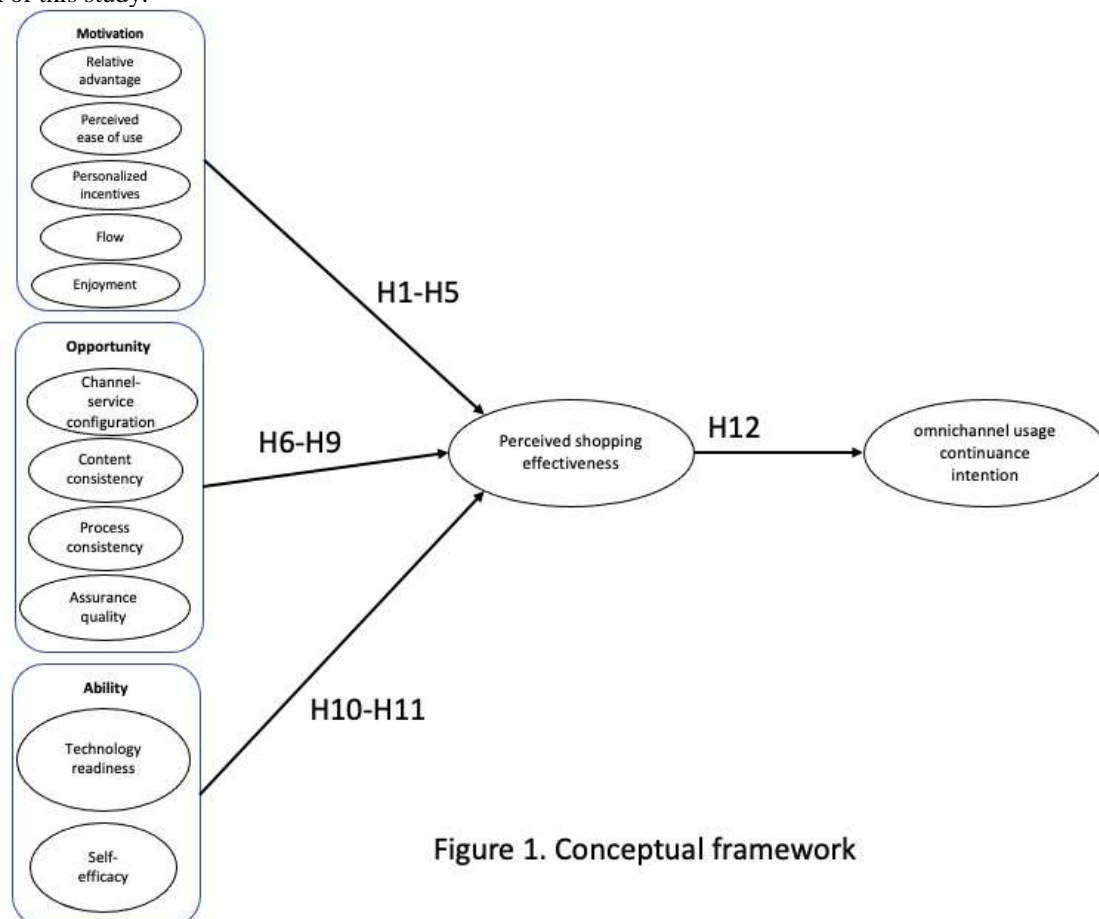


Figure 1. Conceptual framework

Motivation

Motivation refers to the desire or readiness of consumers to accomplish a specific behaviour (MacInnis et al., 1991). As motivation can stem from either an internally generated desire to participate in an act or an external one that arises from the performance of the behaviour (Ryan & Deci, 2000). Thus, this study considers intrinsic and extrinsic motivations as two types of drivers that are more likely to influence the customer perception of shopping effectiveness. Although the omnichannel approach is much more than a technology, its foundations lie in the capability of using technologies during a single purchase (Kopot & Cude, 2021), this study identifies relative advantage, perceived ease of use as extrinsic motivations, and flow, enjoyment, personalized incentives as intrinsic motivations for customer adoption of omnichannel.

Relative advantage is one of the critical extrinsic factors that facilitate the diffusion of innovation (Rogers, 2003). It refers to the extent to which new technology is perceived as offering advanced features and benefits for customers over existing technologies. Shopping with omnichannel offers many advanced features and functionalities such as ubiquitous connectivity, real-time interaction, localised and personalised information, and greater monitoring and support for customers (e.g., shopping efficiency, saving time and effort in shopping) (Kang, 2019; Asmare & Zewdie, 2022). Thus, this study proposes that these advantages can result in perceiving superior shopping values of omnichannel. Therefore, it is hypothesized that:

H1: Relative advantage positively influences perceived shopping effectiveness.

Perceived ease of use is defined as the user's perception of the degree of effort that the user needs to use a specific technology (Venkatesh, 2000). The perceived ease of use is often considered to be opposite to perceived complexity referring to the degree to which customers perceive the new technology as relatively difficult to understand and use (Rogers, 2003). Extending this definition to the shopping context with omnichannel, perceived ease of use is the degree of ease associated with consumers' use of different touchpoints during the shopping process with omnichannel (Juaneda-Ayensa et al., 2016). Balaji and Roy (2017) demonstrated that the ease of use of smart technology is likely to result in customer perception of its superior functionality. Therefore, this study argues that when customers perceive omnichannel as ease of use, they hold a favor of it, which may shape their perception of shopping efficiency with omnichannel. Thus, this study hypothesizes that:

H2: Perceived ease of use positively influences perceived shopping effectiveness.

Personalized incentives refers to the perceived amount of individualized consumer information, services, rewards, and incentives given when using omnichannel platforms (Hsia et al., 2020). Modern consumers increasingly embrace personalized services, thus personalization incentives are widely used in omnichannel retailing (Zhu et al., 2017). For instance, omnichannel platforms provide consumers with purchase recommendations, shopping guides, location-based services (e.g., indoor navigation, reference cues, and route maps), real-time personalized rewards in stores or online (e.g., virtual coupons, red envelopes, and membership points), opportunities to collaborate with friends to earn rewards, and various shopping activities based on their unique preferences, needs, and shopping context. For example, by using detailed individual consumer records and corresponding webpage browsing and consumption analysis, Amazon and Alibaba offer consumers specific and tailored discounts and promotions to induce purchases when consumers shop online (Zhu et al., 2017). Thus, this study proposes that:

H3: Personalized incentives positively influences perceived shopping effectiveness.

Flow is an intrinsic motivation that refers to the positive state of consciousness that users experience when they are deeply involved in an activity (Ameen et al., 2021). The state of flow occurs when a consumer is so immersed in a compelling experience. In the flow state, consumers' awareness become concentrated on the activity itself, completely absorbed in the activity while feeling that they have control over their environment (Csikszentmihalyi, 2000). According to this definition, consumers are in a state of flow during shopping process with omnichannel when they are completely focused on shopping and nothing else (e.g., lose track of time, lose self-consciousness about other activities). Prior research studies have emphasised the importance of flow in understanding interactions between humans and technology (Su et al., 2016). As omnichannel encompasses technological features, the flow may serve as a key motivation for its adoption. Consumers can combine mobile apps with in-store shopping, providing flow of continuous shopping experiences to customers. Researchers have examined consumers' shopping experiences through omnichannel using flow as a construct for measuring potential consumer experience (Ameen et al., 2021). Therefore, this study proposes that the deeply immersed state of flow of omnichannel will make customers perceive greater positive shopping values with omnichannel. Therefore, this study hypothesizes:

H4: Flow positively influences perceived shopping effectiveness.

Enjoyment is the extent to which the user of a product perceives the activity itself to be enjoyable, without consideration of any outcomes or gains that may be expected from performing the activity (Davis et al., 1992). According to this definition of enjoyment, activities are performed solely for the pure enjoyment or fun, excitement, relaxation gained from the activity. Based on the original definition, this study defined enjoyment as the degree of pleasure that consumers expect to obtain from using omnichannel for their single purchase. Enjoyment is distinct from the flow. Unlike enjoyment, which results from the pleasure of activities, flow shows intense concentration, and a sense of being in control of the activities and can result from self-directed activities which are not necessary to bring pleasure. Past researchers have shown that enjoyment has a significant effect on technology acceptance (Liu et al., 2015). For example, Liu et al. (2015) found that positive behaviors toward mobile coupons are formed because consumers feel pleasure (enjoyment) in the act of using mobile coupons itself, and Xu et al. (2014) showed that when consumers perceive greater enjoyment, they are more likely to engage with the technology system actively and positively evaluate it. Gao et al. (2015) demonstrated that enjoyment positively influences a consumer attitude towards smart medical devices. Given the proliferation of IT enabled-hedonic characteristics when shopping with omnichannel,

enjoyment could be a critical factor for the customer perception of shopping effectiveness with omnichannel. This study argues that if consumers judge the activity of using a retailer's omnichannel for their shopping to be interesting, they are more likely to engage in shopping experiences with omnichannel and realize more shopping values. Therefore, this study hypothesizes: H5: Enjoyment positively influences perceived shopping effectiveness.

Opportunity

Opportunity refers to the extent to which an individual can engage in a particular behaviour without restrictions (MacInnis et al., 1991). It reflects the situational factors that either strengthen or hinders an individual's behaviour. Opportunity often includes both positive and negative perspectives of resource availability and impediments for achieving the desired behaviours. Due to the benefits of omnichannel, retailers may put efforts into channel integration quality to facilitate customer shopping (Hossain et al., 2020; Mirzabeiki & Saghiri, 2020). Omnichannel integration quality as a hierarchical construct consisting of channel-service configuration with three sub-dimensions, content consistency with two sub-dimensions, process consistency with two sub-dimensions, and assurance quality with three sub-dimensions (Hossain et al., 2020). Channel-service configuration refers to channel performance in terms of providing services at the same level of quality and consistency (Banerjee, 2014). It is mainly the association between services and channels within a firm (Sousa & Voss, 2006). Channel-service configuration consists of three sub-dimensions including breadth of channel, transparency of channels, and appropriateness of channels. Breadth of channel refers to the availability of different channels through which a customer can avail various services (Lee et al., 2019). Transparency of channels refers to customer knowledge of existing channels. It is related to the awareness level of customers regarding the available channels and channel capabilities of the firm (Sousa & Voss, 2006). Appropriateness of channels refers to the suitability of the channel in providing the service (Banerjee, 2014). This study proposes that facilitating channel-service configuration enables customers to take advantages of omnichannel and perform their shopping effectively. Thus, the following hypothesis is proposed:

H6: Channel-service configuration positively influences perceived shopping effectiveness.

Content consistency refers to the consistency of outgoing and incoming information through different channels of the firm (Lee et al., 2019). Content consistency consists of information consistency and transaction data integration as its sub-dimensions. Information consistency refers to the consistency and uniformity of information within all the service delivery channels of the firm (Banerjee, 2014). Transaction data integration refers to collecting customers' transaction data and integrating it within all the channels to provide seamless service (Banerjee, 2014). This approach lets customers be easy to manage their purchase records and quickly access their purchase history, thus facilitating their future purchase decisions. Therefore, customers are highly appreciate for shopping values offered by consistently integrated transaction information. Thus, the following hypothesis is proposed:

H7: Content consistency positively influences perceived shopping effectiveness.

Process consistency is related to service design, which refers to the consistency of various customer-facing elements that are relevant and comparable within different channels. Service's feel, waiting time, image, employee discretion level gauge the quality of process consistency (Banerjee, 2014). This research identifies system consistency and image consistency as sub-dimensions of process consistency. System consistency, which is derived from electronic service quality research and information systems refers to the technical issues of service delivery process, which are required to ensure all the channels of the firm perform at a consistent level (Akter et al., 2016). Image consistency refers to consistent use of the store's brand name, logo, slogan, and color within all the channels (Oh & Teo, 2010). To ensure image consistency, ambient cues of a physical facility such as logo, surrounding colors, music, and overall feel should be reflected through typesetting, graphics, and display colors in websites and mobile apps (White et al., 2013). This approach signals customers to trust the retailer's capability of providing services/products with consistent quality, thus encouraging customers to engage more in omnichannel for their shopping goals. Thus, the following hypothesis is proposed:

H8: Process consistency positively influences perceived shopping effectiveness.

Assurance quality refers to different channel attributes that convey confidence and trust within customers. Assurance of service while using multichannel has been conceptualized as a dimension of channel integration by Hossain et al. (2019). Furthermore, this research conceptualizes Assurance quality through qualitative data analysis, and it confirms privacy, security, and service recovery accessibility within all the channels is required to ensure Assurance quality. Privacy and Security have been researched expansively within e-service quality research (Yoo & Donthu, 2001). Service recovery accessibility refers to offering customers with channels and incorporated systems through which they can conveniently raise their service-related issues to the firm. Research related to service recovery has always emphasized gathering customer feedback (Van Vaerenbergh & Orsingher, 2016). Collecting customer feedback is vital for organizations, as without that service recovery cannot be even attempted. Utilizing different channels easily informs service issues contributes to customers' shopping effectiveness. Thus, the following hypothesis is proposed:

H9: Assurance quality positively influences perceived shopping effectiveness.

Ability

Ability is the extent to which consumers have the necessary resources (e.g. knowledge, intelligence, money) to make an desired outcome happen (MacInnis et al., 1991). As all customers are not equally equipped to engage with omnichannel, thus the knowledge or expertise of relevant products or technology can guide them in the assessment of the benefits of shopping

with omnichannel. Without the necessary skills, even a motivated customer may not adopt omnichannel. Thus, this study considers technology readiness (Parasuraman, 2000), which refers to an individual's propensity to embrace new technology, as a critical customer belief for adopting omnichannel. Past research studies note that high technology readiness enables customers to understand the benefits of new technology better and operate it more efficiently (Blut & Wang, 2020). Along with customers' technology readiness, previous researchers have noted that psychological resources such as self-efficacy referring to confidence in customers' skills or proficiencies in using omnichannel for shopping can facilitate customer adoption of omnichannel (Van Nguyen et al., 2022). High self-efficacy consumers are likely to be more confident in their customers' skills or proficiencies to use omnichannel for a single purchase. They feel comfortable in using omnichannel and realize the value of shopping with omnichannel. In contrast, low self-efficacy consumers feel less comfortable in using omnichannel and thus find no incentive to adopt omnichannel. Formally stated, this study proposes the following hypotheses:

H10: Technology readiness positively influences perceived shopping effectiveness.

H11: Self-efficacy positively influences perceived shopping effectiveness.

Perceived Shopping Effectiveness and Omnichannel Usage Continuance Intention

Perceived shopping effectiveness refers to the extent to which customers perceive omnichannel brings shopping values and enhances customers' overall shopping experience. Shopping effectiveness is determined by the extent to which customers can perform effectively their shopping using omnichannel. Yang and Forney (2013) demonstrated that the customer believes that shopping with mobile will facilitate them in achieving the tasks which is positively related to the intentions to continue using it. A customer experience is considered as high-quality if it can support customers to efficiently acquire products and services (Chen & Yang, 2021) and derive entertainment and pleasure from shopping (Barari et al., 2020). Therefore, this study proposes that continuously receiving values and superior customer experiences from shopping with omnichannel attracts consumers continue using the retailer's omnichannel. Formally stated, this study proposes the following hypothesis:

H12: Perceived shopping effectiveness positively influences omnichannel usage continuance intention.

METHODOLOGY

Sample and Data Collection

To test the conceptual model and hypotheses, a quantitative method with survey data was used. Data will be gathered from an omnichannel retailer's customers in US via Amazon MTurk. To ensure that the respondents who participated in the survey had actual experience using a retailer's omnichannel services, they were asked whether they had had omnichannel shopping experiences with this retailer at the beginning of the survey. Only the respondents who confirmed their previous experience with this omnichannel retailer were allowed to complete the rest of the survey. The convenience sampling strategy will be adopted to collect data. The intended sample size is around 500 valid responses.

Items and Measurement Validation

All of the measurement items in this study will be adopted from prior studies and modified to suit this research context. The ten dimensions of channel integration quality will be adapted from Hossain et al. (2020). The technology readiness and self-efficacy will be adapted from Rosenbaum and Wong (2015), Van Beuningen et al. (2009), respectively. Relative advantage, perceived ease of use, personalized incentives, enjoyment and flow will be adapted from Kim et al. (2022), Kucukusta et al. (2014), Hsia et al. (2020), Dabholkar and Bagozzi (2002), and Wang (2015), respectively. Perceived shopping effectiveness will be adapted from Gao and Bai (2014). Omnichannel usage intention will be adapted from Shi et al. (2020). All measurement items will be scored on 7-point Likert scales.

Hypothesis Testing

Structural equation modeling will be used to examine the conceptual model and hypotheses via SmartPLS software. Finally, to explore the influencing mechanisms of MOA variables on omnichannel usage continuance intention in detail, a bootstrapping analysis with 5000 repetitions will be performed to test the mediating role of the perceived shopping effectiveness within 95% bias-corrected confidence intervals.

RESULTS

Expected Contributions

Scholars and practitioners have paid close attention to omnichannel retailing strategies (Mishra et al., 2021). This study contributes to the emerging omnichannel marketing literature in the following points. First, the findings offer new insight into the salience of the shopping effectiveness regarding omnichannel shopping. The extant literature has identified the important role of an effective omnichannel strategy in loyalty (Chen et al., 2022), product purchases (Bleier et al., 2019), and word of mouth (Rodríguez-Torrico et al., 2021), all of which can create a company's competitive advantage. However, no studies have so far focused on the optimization of the shopping effectiveness in omnichannel environments. By adopting the MOA theory, this study investigates the extent to which motivation, opportunity, and ability variables can boost customers' perception of shopping effectiveness of omnichannel. This study answers the call of Lemon and Verhoef (2016) to go beyond the widely available channel choice models and develop a holistic omnichannel understanding customers' shopping needs to enable its shopping effectiveness. Second, studies have based on channel integration as a significant antecedent of customers' perceptions and behaviors, including their perceived fluency (Shen et al., 2018), customer engagement and word of mouth (Lee et al., 2019), customer empowerment (Zhang et al., 2018), satisfaction (Lee, 2020), perceived value (Hamouda, 2019), and cross-buying intention (Hossain et al., 2020). Yet research exploring how channel integration quality shapes the shopping

effectiveness in an omni-channel shopping context is largely unavailable. This study examines the relationship between channel integration quality and perceived shopping effectiveness. The empirical findings from this study may offer additional information regarding the influential mechanisms of channel integration quality newly reconceptualized (Hossain et al., 2020) to fill the research gap regarding the association between channel integration quality and shopping effectiveness. Thus, this study responds to researchers' calls to empirically test the channel integration quality viewed as a new approach of marketing concept in helping customers' shopping effectiveness (Homburg et al., 2017). In addition, this study elucidates the mediation effects of MOA variables on omnichannel usage intention through perceived shopping effectiveness. Third, previous studies have conceptualized channel integration as a multidimensional construct that plays a fundamental role in improving customer shopping experience and company performance (Hossain et al., 2020). However, the literature to date has focused exclusively on the effects of channel integration without comparing the effectiveness among the dimensions. By examining the four main dimensions with ten sub-dimensions of channel integration practices proposed by Hossain et al. (2020), this study may verify the usefulness of these metrics. Therefore, this study provides a more holistic view of the effects of channel integration quality in omnichannel retailing environments.

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Understanding work behaviors in remote work environments during the COVID-19 pandemic: Transaction cost theory perspective

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ABSTRACT

Previous studies on remote work have not fully understood which roles are suitable for remote work. In our study, we performed the literature review method and developed a conceptual model inspired by transaction cost theory. Additionally, we believe remote work is an optional option in the context of hybrid work during COVID-19. Our conceptual model leads us to believe that remote workers incur some additional perceived costs in the remote work process. We analyze the following four different roles to understand their perceived costs of working remotely: CEO, product manager, database engineer, and administrative employee. We are expected to provide theoretical explanations for what factors influence remote workers' perceived transaction costs.

Keywords: Transaction cost theory, remote work.

INTRODUCTION

Since spring 2020, the COVID-19 pandemic has been forcing people to rethink life. The workers must use remote computer access at home to prevent the spread of the virus explosions, which is called remote work. Remote work refers to a type of work pattern that integrates ICT into work processes to move location away from the physical office (Baruch, 2001, p. 113). Remote work has recently evolved into a hybrid workplace that allows workers the flexibility to choose work location between the physical office and home, referred to as hybrid work. According to a recent SurveyMonkey and Zoom survey (2021), nearly 65% of respondents out of 1500 remote workers in the US say hybrid work is their preferred work style. Particularly, a burning issue is that not every worker is suited to hybrid work, as techwireasia reports. This practical question thus offers an interesting basis for scientific discussion.

Because of the dual nature of hybrid work, we can discern the worker's place of work: the physical environment and the remote environment. In our study, we focus on the analysis of remote work. Two major areas in previous studies on remote work have been organizational control (Brice et al., 2011; Errichiello & Pianese, 2016; Groen et al., 2018) and technology acceptance (Daniels et al., 2001; Ndubisi & Kahraman, 2005; Mayo et al., 2009; Neirotti et al., 2013; Ansong & Boateng, 2018). However, little is known about the hidden costs (such as search costs, enforcement costs, bargaining costs, and examination costs) that workers suffer while working remotely. Hence, we completed the literature reviews to identify the research gap and propose a conceptual model based on transaction cost theory and show available evidences for the proposed propositions. We selected four different roles (CEO, product manager, database engineer and administrative employee) in the organization that have their key responsibilities. We develop some propositions to answer these following questions: (1) What factors are associated with the perceived transaction costs of doing business remotely? and (2) How does each factor affect perceived transaction costs? The results of this study will help determine the applicability of remote workers.

Given the lack of scholarly research on this urgent but intriguing topic, we believe there is an urgent need to apply the new model to support the differential impact of employee role attributes on remote workers' costs. This study would not only help to understand hybrid work (i.e. remote work and physical office work), but also offer entrepreneurs practical human resources management. The rest of this paper is organized as follows. First, we introduce remote work and the concept of transaction cost theory. We will then review some arguments and present some research proposition for the model. Next, we will present the expected contribution, including theoretical and practical implications of our results. Finally, we acknowledge the limitations of the study.

LITERATURE REVIEW

The Nature of Remote Work

Remote work is often associated with organizational behavior (Ndubisi & Kahraman, 2005; Carillo et al., 2020) (Table 1). Remote work involves relative uncertainty in communication and performance (Brice et al., 2011). These issues are technical and environmental in nature, affecting the intention of corporate stakeholders to adopt remote information systems (Ansong & Boateng, 2018). A perfect consideration of the arrangement of remote work should first understand the antecedents of the

adoption of remote work and establish the relationship between organizational control and outcomes (Errichiello & Pianese, 2016). Meanwhile, the onset of remote work adoption (e.g., the early adopters and the late adopters) would shape the structure of the organization (Daniels et al., 2001).

A common observation related to remote work is that there is considerable debate among academics about the behavior of remote workers. Remote workers increase in-person work efficiency as some associated transportation costs (e.g., fuel oil costs and travel expenses) are reduced (Ansong & Boateng, 2018). Likewise, remote workers receive less monitoring and improve their job performance (Groen et al., 2018). On the other hand, some researchers have argued that remote workers experience long hours and surveillance at work (Xiao et al., 2021; DeFilippis et al., 2020; Bolisani et al., 2020). However, the efficiency and performance of remote workers is highly dependent on their IT skills (Staples et al., 1998; Silva-C et al., 2019). Furthermore, the descriptive characteristics of remote workers (e.g., work experiences and task types) are often also used to assess individual remote work outcomes (e.g., satisfaction, ability, and performance) (Turetken et al., 2010; Nakrošienė et al., 2019). Job characteristics can also cause a difference in remote worker acceptance (Mayo et al., 2009).

Table 1: The overview of remote work behavior

Sources	Aspects hierarchy	Adoption theories	Focuses
Staples et al. (1998)	Individual	Self-Efficacy theory	Performance
Daniels et al. (2001)	Organization	Neo-institutional theory	Adoption
Ndubisi & Kahraman (2005)	Organization	Resource based view/ Agency theory/ Institutional theory/ Societal marketing concept	Remote work adoption
Mayo et al. (2009)	Organization	Contingency theory	Remote work adoption
Turetken et al. (2010)	Individual	Distributed work arrangements (Collins, 1998)	Remote work success
Brice et al. (2011)	Organization	Transaction cost theory/Agency theory	Output and behavioral controls.
Neirotti et al. (2013)	Individual	Technology-organization-environment framework (TOE)	Remote work adoption
Errichiello & Pianese (2016)	Individual, groups, and Organization	Structuration theory	Organizational control
Groen et al. (2018)	Individual	Control theory	Output controls
Ansong & Boateng (2018)	Organization	Technology-organization-environment framework (TOE)	Remote work Adoption
Nakrošienė et al. (2019)	Individual	Job demands-resources theory (JD-R)	Remote work outcomes (e.g., productivity)
Silva-C et al. (2019)	Individual	Technology acceptance model	Remote work attitude
Carillo et al. (2020)	Individual	The theory of work adjustment (TWA)	Remote work adjustment
<u>Our Study</u>	<u>Individual</u>	<u>Transaction cost theory</u>	<u>The willingness of doing remote work</u>

Source: This study.

The Applicability of Transaction Cost Theory to Remote Work

The transaction cost theory was first articulated by Coase (1937), who points out that transaction costs stem from the additional costs in addition to the price mechanism in the market economy. These cost elements can be categorized into ex-ante (e.g., search costs) and ex-post costs (e.g., monitoring costs). Later, Williamson (1985) expanded the original concept to add the dynamic effect. To put it another way, environmental uncertainty, complexity, low transaction frequency, information asymmetry, and poor transaction atmosphere all contribute to failure.

The transaction cost theory has been successfully applied in many aspects. Established examples include applications of transaction cost theory in the areas of corporate governance (Kochhar, 1996; Teece, 1986; Saravia & Saravia-Matus, 2014; McClelland & O'Brien, 2014), online shopping (Wu et al., 2014; Teo, 2006; Si, 2021; Che et al., 2015; Liang & Huang, 1998), and supply chains (Grover & Malhotra, 2003; Ketokivi & Mahoney, 2020; Ma et al., 2022; de Goeij et al., 2021). Transaction cost theory is often used to evaluate decisions affecting a range of channel or product integration options. Klein (1989) examined companies' channel integration decisions in foreign marketplaces. Liang et al (2021) discussed the valuation of products sold online. Since remote work is an alternative compared to the physical office, it is reasonable to assume that workers would prefer the style of work with lower perceived transaction costs. While workers are drawn to the convenience of remote work, they also perceive various uncertainties through the remote work process that increase their transaction costs. For example, they might be concerned about IT disruptions or message misunderstandings. Using this example, this makes the

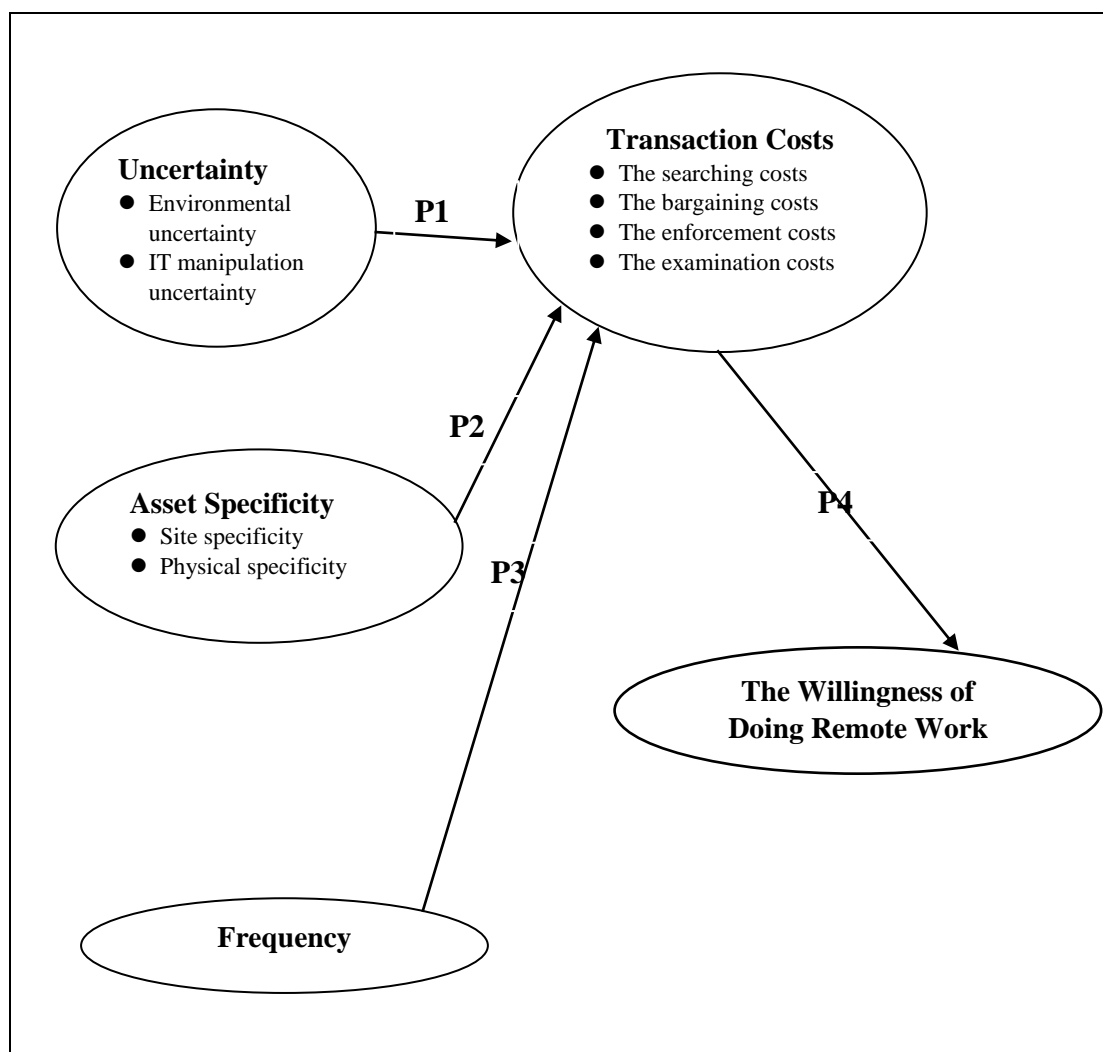
transaction cost theory being reasonable interpretation of remote work behavior. As a result, we highlight whether the worker would choose to work remotely, which is determined by workers' perceived transaction costs.

RESEARCH METHOD

We reviewed the literature on the theoretical perspective of remote work to attempt a solution to the practical issue of which role is a good case for conducting remote work. Nevertheless, most studies emphasize how the relationship between the remote system and the remote workers affects organizational development. Therefore, we determine the appropriate use of the transaction cost theory in the context of this research question. Finally, we propose a research model with the structural equation modeling.

THE PROPOSED MODEL

We performed a novel model using transaction cost theory after analyzing the theory's feasibility from the literature reviews (Figure 1). In our study we analyze four roles, for example the CEO, product manager, database engineer, and administrative employee. The next step is to provide some evidence to support the proposed propositions.



Source: This study.

Figure 1: Research model

Proposition I: More uncertainty leads to a higher transaction cost (P1).

Uncertainty arises from unpredictable and unverifiable events (Geyskens et al., 2006; Gulati & Singh, 1998) related to the costs associated with the asymmetric information (Liang et al., 2021; Cuypers et al., 2021). From the remote worker perspective, we argue if CEO, product manager, database engineer and administrative employee choose the way of working remotely and then they would create the challenge of environmental uncertainty and IT manipulation uncertainty. Environmental uncertainty basically refers to the unforeseen changes in the circumstances of the exchange (Noordewier et al., 1990). These workers transfer information via ICT to achieve the work goals, which can be considered as an environment for information exchange. Compared to the physical office, the collaborative interaction between the remote workers remains more static and isolated (Yang et al., 2022). Such uncertainty causes a craving for flexibility (Klein, 1989). Consequently, the remote workers receive the less dynamic message changes in the remote environment. Another suggested uncertainty is the

manipulation of uncertainty by IT. The uncertainty of IT manipulation relates to the frequency of updates and the unpredictability of the ICT software that causes the perceived uncertainty for the remote workers. In most cases, one such uncertainty in IT manipulation is the fuzzy relationship between technical requirements and precise expectations (Walker & Weber, 1984; Anderson et al., 2016). If the remote system's software is updated rapidly, the computer system may lead to bugs. In this situation, the remote workers would spend so much time adopting the new change of the software. Then it is inevitable to encounter the consequences of workers' performance degradation and users' preference, which is certainly associated with willingness. In addition, the uncertainty is associated with the contextual environment (Williamson, 1975). We believe the remote workers would have the dual perceived behaviors that would create a sense of insecurity.

Proposition II: More asset specificity leads to a higher transaction cost (P2).

Asset specificity refers to the enduring investments made to support specific transactions (Williamson, 1985, p. 55). Asset specificity is at the core of transaction cost theory (Williamson, 1981; Whyte, 1994; Lamminmaki, 2005), which is used when jointly considered product complexity and uncertainty (Shelanski & Klein, 1995). In our study we draw inspiration from Williamson (1983) and distinguish two types of asset specificity: (1) site specificity and (2) physical specificity.

Site specificity refers to superior site implying resource acquisition but associated relocation costs (Williamson, 1983). Turyahikayo et al. (2018) implies that asset specificity increases demand coordination. Therefore, we argue that some jobs that require human interaction and cross-team collaboration have higher site specificity.

Physical specificity refers to the use of specialized tooling required for component manufacture (Williamson, 1983). Under this definition, this can be construed as the necessities during the production process. Therefore, we believe that some maintenance jobs would have higher physical specificity due to the centralized computer system in the physical office. In theory, as asset specificity increases, the trader strives to control opportunistic behavior, which incurs more transaction costs (Williamson, 1985).

Proposition III: More frequency leads to a lower transaction cost (P3).

Frequency represents the number of repeat purchases in the transaction (Loebbecke & Huyskens, 2006; Aubert et al., 1996). Therefore, we define frequency as the times when technology tools are used to perform remote work. For hybrid work, frequency also impacts workers' perceived transaction costs and their willingness to work remotely. For dealing with technological tools and virtual workshop platforms, the reaction to the level of uncertainty in the transaction process is differentiated for those familiar and unfamiliar with using technological tools and virtual workshop platforms. The more frequent the transaction process occurs, the more transaction costs are mitigated (Miranda et al., 2006). The appropriate frequency brings the benefits of efficient use of the resources involved (Walker & Weber, 1984), which can reduce search costs for remote workers.

Proposition IV: More transaction cost leads to a lower worker's willingness of doing remote work (P4).

In remote work, the different workers at the different positions can access a wide variety of services and start their work business via a virtual environment. Further, the different attributes of job responsibility reflect transaction costs in various ways. The remote workers face more discontinuities due to the complexity of the environment (Watson-Manheim et al., 2002), which may lead these individuals to search for enough information to avoid the scatter problem (such as information asymmetry). The perceived discontinuities result from the differences between job expectations and reality (Watson-Manheim et al., 2012). We believe that work administration would exacerbate the discontinuities for their employees in the virtual environment and that remote workers need to meet their needs by seeking appropriate aids. In addition, the level of bargain is based on the level of the social norm (Misyak et al., 2014). The higher social norm gives clear normative trends and then the remote workers set the threshold to consultant with the coworker. The nature of the bargain cost can be viewed as the quality of communication efficiency (Langer, 2017; Berry, 2011). When the remote workers thus need to conclude suggestions from members and present the list to the superiors, then increase the bargain cost. The virtual work experiences are a facilitation to acclimatize remote workers to the new working conditions (Gajendran & Harrison, 2007; Raghuram et al., 2001), which affects the enforcement period. Such adaptation arises from the gap between the remote work environment and reality. We believe that if the employee's role typically relies on computer systems for their work, the role of employees would receive fewer enforcement costs. Even though remote work is often viewed as a resource for adapting to the new workplace, it can lack accuracy in gathering information (Al-Habaibeh et al., 2021). We think that the job of remote employees involves human resources and human interaction, which increases the examination cost in a virtual environment for themselves. In our study, four types of transaction costs are involved in the worker's willingness of doing remote work. These transaction costs include:

- 1) The searching costs: The worker spends time and effort searching for information among various search engines or social media making the task easier.
 - 2) The bargaining costs: The worker spends time and effort online coming to a consensus regarding the details of the work task.
 - 3) The enforcement costs: The worker spends time and effort online ensuring the goal of the completed work task because of unpredictable occurrences.
 - 4) The examination costs: The worker spends time and effort online performing the acceptance test on all tasks.
- Based on these observations, the worker would choose transaction forms that cut down the perceived transaction costs.

CONCLUSION

The aim of this study is to propose an innovative conceptual model by resorting to transaction cost theory. In this study, we try to show the applicability of transaction cost theory to hybrid work through literature reviews. Overall, we examine the emerging role of hybrid work in the context of COVID-19. In our research model, we analyze the four different types of positions (CEO, product manager, database engineer, and administrative employee). We expect the empirical results to be as follows: CEOs and database engineers would be more likely to work remotely than product managers and administrative employees. This is mainly due to the variance of the individually perceived transaction costs. This expected result was in part similar to Brynjolfsson et al. (2020), in which a large number of employees in managerial and professional roles are moving to the home office. Both roles can avoid spending unnecessary time on conversations. The list and number of personal task arrangements vary across space (i.e., physical and virtual space) (Felstead et al., 2003), which can impact cost generation. Compared to working in the physical office, remote workers (CEOs and database engineers) increase search costs and negotiation costs, but instead decreases audit costs and enforcement costs. The CEO specializes in shaping the organization's decision-making process and the database engineer specializes in keeping the data secure. The characteristic of their work is not limited to space and time, which suggests that CEO and database engineer can focus on solving problems through remote work. Nowadays almost all CEOs take mobile phones to do all business. We believe the CEO makes better decisions without going to the office to make decisions. The use of computers is also a database engineer's forte. We believe that database engineers retain their professional skills in virtual workplaces, which increases a rich focus on computer system maintenance. However, for the database engineer working in the company that equips the core computer system in the physical office, the physical asset specificity could increase to get the specific resources in a reality office. In contrast, professional responsibility requires the process of a series of negotiations (the product manager), and countless different office tasks (the administrative employee) are less suitable for remote work since these jobs rely on human interaction to increase work efficiency. The physical office has the absolute advantage that team members can easily interact with each other face to face. In addition, face-to-face engagement is particularly important in establishing early levels of trust and familiarity with remote work (Bailey & Kurland, 1999). We believe product managers easily link the sense of trust when working in the physical work environment. Additionally, administrative employee can reduce search costs by working in the physical office. Hill et al. (2003) found that remote workers often face the problem of a lack of face-to-face meetings with their managers, leading to stagnation. We believe that administrative employee in remote environments experiences the challenge of a more comfortable relationship with their manager and can ask back and forth for more confirming the needs at work, which is related to the examination cost. Meanwhile, the ease of ICT influences the assessment for remote workers (Wheelan et al., 2016), which administrative employee should pay attention to the usability of technology in virtual environments. Thus, we conclude that the higher an individual's perceived transaction costs, the less likely they are to work remotely.

As with any academic research, we provide the limitations of this study and suggestions for future research. First, the proposed propositions can only provide the preliminary statements to confirm the practical observations, and empirical examination is required to establish theoretical structures. Second, the underlying costs of remote workers need to be further evaluated in future study. In our study, hybrid work is an alternative between physical office work and remote work. Future research needs to examine the actual transaction cost factors that may come close to the dynamic change in remote workers. Third, we do not know enough about the cost events in these remote workers and how they happened, the scholars may need further interviews to gain meaningful insights. Fourth, given the differences in corporate cultures around the world, the results may not meaningfully extrapolate to other remote workers. Fifth, because of the differences between the characteristics of remote workers, further empirical investigation is needed regarding the generalizability of the cost of personality to individual remote worker's willingness.

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Usability evaluation of a mobile health application by older adults in Thailand

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ABSTRACT

As the world's population is aging, research on older adults and their use of IT is becoming more important. Usability issues were found one of the main problems hindering older adults from using IT, including mobile health application. This study aims to understand older adults' behavior and to identify barriers and enablers for using a mobile health application, called Raksa. Two theories, namely Usability and Accessibility were adopted as a conceptual framework. A think-aloud protocol, a system usability scale (SUS), and in-depth interviews were utilized. ISO 9241-11 guide was used for identifying usability performance level of Raksa application based on think-aloud approach. Task incompleteness rate, error rate and time on task were calculated to assess effectiveness and efficiency. Interviews were conducted for validating reason of use and comment on the application design, using Nielsen's 5 quality components namely, Learnability, Efficiency, Memorability, Error and Satisfaction. The results showed that the task to find a medical specialist for a consultation was deemed the most difficult by the participants as it has the lowest task completed rates and the longest times on task. The task to create account and register had the most errors. The average satisfaction (SUS score) was 31.50, indicating poor system usability. Demographic data showed males were more successful in task completion. Educational level were related to task performance, and older adults with more experienced in information technology or social media achieved higher performance rate. This research identified usability problems and barriers that may affect usability in older adults, including visual design, poor interaction and navigation, user interface difficulty to understanding. Recommendations for design modifications were offered.

Keywords: Usability evaluation, mobile health application, system usability scale (SUS), older adults..

INTRODUCTION

The COVID-19 pandemic has increased the use of telemedicine applications (Aldekhyyel *et al.*, 2021). Telemedicine system has the potential to improve the quality of life for many populations. As the world's population is aging, research on older adults and their use of information technologies is becoming more important. However, the adoption and continued use of mobile health application among older adults is low. There are usability issues that often hinder older adults from using information technologies. One of the main reasons is that most of healthcare mobile applications in the market do not carefully take into account the needs, preferences and individual ability of elderly people, resulting in usage difficulties and thus low usage number. Besides, older adults tend to face additional challenges, compared to younger people, in using Healthcare mobile applications (Charness & Boot, 2009), due to both the limitations of motion-sensing and intellectual abilities (McAlister & Schmitter-Edgecombe, 2013).

The problem in healthcare mobile application usage among older adults can still be seen continuously (Somjai, 2021). As mentioned earlier, a lack of skills and knowledge to use digital technology makes it difficult for older adults to access and use such an application, despite its benefits. However, given the higher number and percentage of older adult populations, older adults will soon be a major group of healthcare mobile application users. Therefore, healthcare mobile application should be evaluated and redesigned from the perspective of older adults so that it is more user-friendly to them.

Literature on Human-Computer Interaction (HCI) has found several factors influencing IT adoption by older adults, including usability and easy-to-navigate user interface (Lee and Coughlin, 2015). Nowadays, applications designs are complex which makes it even more challenging to use by elders due to various limitations, for instance, motion-sensing and intellectual abilities. Therefore, an application must be properly designed for older people. And in order to ensure that they are able to use it, there must be an assessment to identify obstacles that limits its use, and to improve them accordingly.

This study, thus, set to understand the reasons that the older adults do not use a mobile healthcare application and identify barriers and facilitating factors for the use of the mobile healthcare application.

LITERATURE REVIEW

Older adults and their use of m-health application

Mobile health application is a healthcare system where mobile devices are used to facilitate healthcare and medical management. The system is useful especially for patients in remote area. Regardless of its benefits, m-health systems have

been slowly adopted; some are discontinued. The reasons are usability problem, such as inefficient system design, lack of ease of use, accessibility problem, inconsistencies between system features and user needs and between expectations and characteristics (Jimison et al., 2008; Or & Karsh, 2009).

At present, older adults' adoption of mobile devices is higher; however m-health application is rarely mentioned and used (Bender et al., 2014). Older adults usually have problems with technology adoption due to their age and IT skills (Ractham et al. 2022). Therefore, it is necessary to study the problem to ensure that older adults can use the health application effectively. Younger users seem to be positive with the adoption of medical-related products/services (Kaewkitipong, et al. 2022). However, older adults may have different and specific concerns on the adoption, as they have limitations in their perception of movement and cognitive skills that may affect application usability (Czaja, Boot, Charness, & Rogers, 2019). Application that is properly designed with consideration on the needs and limitations of elders may solve the aforementioned issues. For elderly population to be able to use m-health application effectively, the application must be suitable for the characteristics of the elderly users.

Prior studies, which assessed usability of mobile application for older adults, have highlighted issues that may limit the usability of the aging population. The majority of usability problems for older adults include small fonts and screens (Gao et al., 2017), inappropriate use of colors (Kamana, 2016), unclear instructions (Grindrod et al., 2014), too many functions (Isaković et al., 2016), and too many unnecessary steps within an application (Cornet et al., 2017). In general, these problems occurred because physical limitations of older adults were not taken into consideration when an application was designed. Older adults usually have problem comprehending and navigating difficult-to-use and complex applications; besides they have declining short term memory, resulting in confusion when using an application is complex and involves many usage steps (Mitzner et al., 2013). The design of the application that is inappropriate or does not support the needs of the elderly affects the ease of access and use. However, ease of use has been widely acknowledged as a key success factor for IT, including mobile applications not just in the context of healthcare (Iyanna et al. 2022). Therefore, usability assessment is important as it will allow an understanding of user's behaviours, attitudes and opinions from system usage and reveal problems and barriers that limit usability and bring the findings to improve accordingly.

Usability Evaluation Framework

Usability testing is based on Human-Computer Interaction (HCI) literature. Usability indicates the success that a user achieve compared with his or her goals while using an application or a system. In other words, an application or a system with high usability offers good user experiences and enables its users to achieve their tasks. ISO 9241-11 defines a standard to measure usability during user interaction with a system. The standard includes metrics for effectiveness, efficiency and satisfaction (Quesenbery, 2003). According to Quesenbery (2003), Effectiveness concerns rate of task completion, error, and additional assistance that users may seek. Efficiency focuses on the quantity of resources required to complete a task; if a lot of efforts and resources are required in order to use an application to complete a task, the application is considered inefficiency. Satisfaction involves positive attitudes of users towards the use of an application or system. Similar to ISO 9241-11, a usability expert, Jakob Nielsen (1993), describes usability as a feature used to assess the ease of use of a user interface. It also means a way to improve usability during the system design process. Nielsen has defined five qualitative elements for usability, including learnability, efficiency, memorability, error, and satisfaction. Table 1 compares the dimensions of usability from the two sources.

Table 1: Comparison of usability dimensions

ISO 9241-11 (Quesenbery, 2003)	Nielsen (1993)
Efficiency	Efficiency
	Learnability
Effectiveness	Memorability
	Errors/Safety
Satisfaction	Satisfaction

An early usability evaluation is essential to guide the development of the design process in the direction of universal access right from the start. It is also an important step in user-centric design. This assessment should occur at every stage in the system lifecycle. Evaluating user interface features can anticipate and explain usability and accessibility issues, which can be performed before the system is used. The objective of evaluation is not only to address user interface issues, but also should have an ultimate objective, which is to achieve product design that meets system usage goal which can enable users to achieve their goals of use and satisfaction with the product (Karat, 1997).

The results of all assessments should visualize how easily the user can operate. There are two most common methods. 1) Usability Inspection, which is an assessment performed by experts. 2) Usability testing which is an assessment that requires a representative of the users to participate in the test. Testing by users is the most important and helpful guide. This is because it provide information about how real users are using user interface and clearly shows issues the users encounters during the interactions (Nielsen & Mack, 1994). Generally, user testing is done using the Think Aloud protocol. Questionnaires or interviews are also useful and simple assessment methods for collecting information about user satisfaction or satisfaction with the user interface (Rogers et al., 2011; Rubin, 2008).

Evaluation of usability of healthcare and telemedicine applications

Hong *et al.* (2014) studied usability and acceptance of iCanFit, which was an application designed for promoting exercises among older adults. Thirty three older adults were recruited to use the application. Creating a user account was found the most difficult task for the participants in this study as it was the task that took the longest time to complete. However, approximately 56% of the participants were happy with the application in general and mentioned that they would recommend the application to their friends and family.

Lilholt *et al.* (2014) tested usability and gathered suggestions concerning usage and satisfaction with the Telekit, a telemedicine system for patients diagnosed with chronic obstructive pulmonary disease (COPD). The think-aloud method was applied; 6 patients were asked to use and think out loud while using the Telekit system. The authors found that the participants were more interested in the usability in terms of whether or not the system could help them achieve what they have to do rather than whether the user interface was designed nicely and allowed ease of use or not.

Constantinescu *et al.* (2018) conducted usability testing of a mobile health application for in-home swallowing therapy. Efficiency, Effectiveness and satisfaction with the system were measured. The research showed that despite self assessing themselves as highly skillful in using IT applications, some participants needed more time to get used to the application. Some tried to swipe to the next screen, though the current screen was the last one.

Georgsson & Stagers (2015) applied ISO 9241-11 and the System Usability Scale (SUS) questionnaire to assess usability of the Care4Life application, a mobile healthcare application for patients diagnosed with diabetes. It was found that editing Glucose value and exporting the Glucose value into pdf format were the most difficult task, involving highest error rate and taking the longest time to complete. In addition, gender was found related to effectiveness. From the usability testing, male participants in the study completed the given tasks more than female did. In addition, younger participants achieved higher efficiency score than the older did. Education background did not seem to affect the efficiency; on the other hand participants with more experiences with IT achieved higher efficiency score than those with less experiences did.

Or & Tao (2012) attempted to evaluate user interfaces of a computer-based self-Management system for older adults with chronic disease. Fifty participants were recruited to test a paper prototype of the system, using the think-aloud method. System navigation, information search within the application, information interpretation, and information presentation and readability were found to be major usability problems. The authors recommended that usability test should be conducted especially during the system development process to help increase system effectiveness.

Pointing to a lack of design guidelines specific for mobile application for older adults, Morey *et al.* (2019) evaluated the usability of three mobile health-related applications, using cognitive walkthroughs, heuristic analysis, and user testing. Poor navigation system, small sizes of interfaces (e.g. buttons and icons), color choices (no clear different between background and foreground), and inadequate data visualizations were found major problems obstructing the use of the older adults in this study.

Mehra *et al.* (2019) conducted a usability study of a tablet-based application designed for supporting older adults to exercise at home. Similar to other usability study, the researchers applied a think-aloud approach, asking the participants aged 69 to 99 to try using the app to complete a series of given tasks and verbalizing their thoughts. Efficiency was assessed by the amount of time the participants spent on completing a given task. Satisfaction was also assessed. Overall, the participants were satisfied with the application and able to complete the given tasks. However, the authors pointed out that factors affecting long-term usability or continuance use could be different and required a follow-up study.

Isaković *et al.* (2016) tested the DeStress Assistant (DeSA) application to evaluate its usability for elderly users. The study highlighted the need to involve the older adult users in the application design and development phases as this group of users appeared to have specific needs, including visibility problem and reluctance to IT use. In addition, as the older adults would be a majority group of users of mobile health applications, the usability testing with older adults would allow the developers to improve an application's interface that supports the older adults' needs better.

Panagopoulos *et al.* (2019) conducted a usability assessment of a homecare application for older adults. Thirty older adults were recruited to participate in the two-step usability test session. The usability test in this study showed that despite experiences in using mobile application and positive attitudes towards IT application, the older adults found the application difficult to use. The study confirmed the needs to involve older adults in the design and development phases, highlighted by Isaković *et al.* (2016). It showed that by redesign user interfaces of the homecare application according to the older adults' suggestions, the application had achieved the higher system usability score, associating with higher user satisfaction.

Tang *et al.* (2016) applied heuristic evaluation to test usability of a digital emergency medical services system. The authors highlighted that usability should be set high priority for the development of a telemedicine system and that heuristic evaluation is an effective usability testing method.

Ryu *et al.* (2020) studied user experiences of neurosurgical care telemedicine system during COVID-19 period. Increase convenience for patients was perceived as a major benefit of the system, while an inability to perform a neurological

examination via the telemedicine system was a major barrier. However, the authors argued that the use of telemedicine was likely to continue after COVID-19 as an adjunct tool for patient care.

Similar to Ryu *et al.* (2020), Aldekhyyel *et al.* (2021) had also evidenced an upward trend of telemedicine adoption during COVID-19 pandemic. The authors evaluated the usability of telemedicine applications used in Saudi Arabia during the pandemic and highlighted the need for user instructions as well as help and documentation. In addition, as users may have different experience and IT background, adding flexibility to the system, for example by allowing users to create shortcuts or customize user interfaces, may help create a more positive user experience.

Referring to the need to limit the use of hospital resources during COVID-19, Costagliola *et al.* (2021) pointed out that an improvement of telehealth or mobile health applications in terms of usability are important. Attempting to provide guidelines on improving usability of the applications, Costagliola *et al.* (2021) conducted usability testing of a mobile health application called YouCare. The usability testing, however, was conducted with young users who are experienced in the use of smartphones and achieved a good System Usability score. The authors noted that a less experienced user may find the application more difficult to use.

Choemprayong *et al.* (2021) also conducted a usability evaluation of a mobile telemedicine application, called MEDIC, which was used for orthopedic specialists to provide consultations with physicians. The authors summarized that MEDIC appeared to be quite satisfactory, although errors in data input, action failures, and misinterpretation of data were reported as most critical issues during the usability test. A limited screen size and resolution of a mobile device was reported as a cause of poor usability.

From the above reviewed literature, most studies were conducted with applications or systems that were specific for one disease or symptom. Besides, most users were patients. However, we have not seen prior studies that focused on mobile health application that was designed for generic and primary consultation and support for those who may not yet fall ill. For a more generic application, usability design may be different. This study, thus, attempts to conduct a usability testing on a mobile health application, which is not specific to one disease and see if there might be different usability issues.

RESEARCH METHOD

This research applied a mixed method approach to examine usability of Raksas application. A usability testing of a mobile healthcare application was conducted using a Think-Aloud method followed by in-depth interview. A questionnaire was also administered after usability test to gain insights into behaviour and thought process and attitudes of participants. A mobile healthcare application, called RAKSA, was chosen in this study as it was one of the most popular and the most complete (in terms of functionalities) mobile healthcare application in Thailand.

Participants

As the usability testing is best to be conducted with face-to-face explanation from a researcher at the beginning of the session, and the researcher needs to observe and record what a user thought while using the application. Participants aged 60 years and over were, therefore, selected based on their convenience and permission. Snowball technique was also applied in order to reach 20 older adults who were able to participate in trying and testing the RAKSA application. All participants have been using mobile devices but not mobile healthcare application before participating in the usability testing session. However, 10 of them had some basic skills and familiarities with mobile devices, smartphone application or actively used social media, while the other 10 participants had no IT background and were not a heavy mobile user. The differences in terms of background of participants were intended so that it may allow for comparison between the two groups.

Procedures

Demographic information were collected first, then participants were introduced to RAKSA application and its basic usage. Think-Aloud Method and research steps were explained to participants individually and face-to-face. The participants were then asked to complete five assigned tasks (Table 2) with RAKSA application. They were specifically instructed to speak their choices and thoughts out loud, while using the application to complete each task. The tasks were chosen from the main features of the app, with varying levels of difficulty. The researcher simulated a scenario for participants to imagine along and interact with application according to the situation; meanwhile the researcher would observe users' behaviour, record errors that participants made, and collected length of time made by participants during work. After the participant had completed the assigned tasks, they were required to complete a Post-Test Questionnaire, employing System Usability Scale (SUS) (Georgsson & Stagers, 2015), to assess their satisfaction after use (see Appendix A). Lastly, participants were interviewed, employing a semi-structured set of questions, about their attitudes, reasons for not using the application yet, difficulties/challenges they faced while using the application, facilities and guidelines for improving the application. All tests were recorded in writing and in video format.

Table 2: Five tasks that each participant need to complete while using RAKSA application.

Tasks	Target
1	Register to the application for user account
2	Find articles about an illness
3	Find a specialist doctor for consultation
4	Edit user's profile
5	Find and try to order medicines

Data Analysis

Data analysis was divided into two parts: 1) an analysis of usability testing data from the Think-Aloud method and from the SUS questionnaire and 2) an analysis of in-depth interview data.

An analysis of usability testing data

For an analysis of usability testing data, usability dimensions defined by ISO 9241-11 (Bevan, 2009) were adopted to assess usability of the application. According to Bevan (2009), there are 3 dimensions of usability. Each dimension can be measured as follows:

- Effectiveness - measured by the level of completion of a task and the total number of errors that occur while attempting each task. The task completion levels are 1) completed easily where the test participant was able to work on their own, 2) completed with difficulty where the test participants encountered obstacles or sought advice from the researcher; and 3) failed to complete the task where the test participant is unable to complete a task or requests to cancel during the test. Errors were counted when the test participant was unable to fix and complete the task, both intentionally and unintentionally. The more errors there were, the less effectiveness the application was.
- Efficiency - measured by the amount of time a participant took to complete each task, which was calculated from the time from the start to finish.
- User satisfaction - measured by a System Satisfaction Questionnaire (SUS) score, developed by John Brooke (1995). The SUS consisted of 10 usability questions, using a likert scale of 1-5. The SUS scores were then calculated in accordance with Brooke's guidelines. The score were calculated into percentile format, which indicates the degree of satisfaction with the application compared to the average benchmark score. If the score was greater than or equal to the standard mean score, or 68, it means an application achieved an average or a pass satisfaction score (Bangor et al. 2009; Brooke, 1995; Lewis & Sauro, 2011).

An analysis of in-depth interview data

Data from in-depth interviews together with observations of user behavior during usability test were interpreted based on Jakob Nielsen's definition of usability concept. Five elements of usability, defined by Nielsen (1995) included 1) Learnability 2) Efficiency 3) Memorability 4) Error and 5) Satisfaction. The analysis was to understand 1) why participants were satisfied or unsatisfied with the application, 2) what were the problematic steps within the app (if any) and why did they think the steps was problematic (difficult to use), 3) what should be redesigned to make the app easier to use.

FINDINGS

Participant Demographics

Grouped by Gender, participants comprises 7 males and 13 females aged 60-72 years. An average age of the participants was 63.15 years. Thirty five percent of the participants graduated at the elementary school level. Approximately 30% of the participants graduated at the Secondary school level, while the rest (35%) achieved bachelor's degree or higher.

Results from usability testing

Results from usability testing of RAKSA application by the twenty older adults participating in this study are discussed in 3 dimensions, including effectiveness, efficiency and satisfaction.

Effectiveness

Task 3 (Find a specialist doctor for consultation) appeared to be the hardest task to complete. From the test, it was found that 40% of the participants failed to completed the task. The second hardest task, which has second highest failure rate was Task 1 (Register to the application for user account) and Task 4 (Edit user's profile) with an exactly same failure rate at 20%. Task 2 (Find articles about an illness) and Task 5 (Find and try to order medicine) appeared to be the easiest task, with a job failure rate of 5%.

The error rate was also calculated to indicate the difficulty, facing by the participants, in performing the five tasks. The results showed that Task 1 (Register to the application for user account) has the highest error rate at 80 percent. The most common errors are: 1) Press the arrow to select the date of birth in wrong direction 2) press the letters that says birthday which they could not. 3) Press the letters that says confirm the phone number which they could not do and 4) fill in the last name in the box for real name and press letters that says fill in personal information, which they could not. The task which had the second highest error rate was Task 3 (Find a specialist doctor for consultation). It was found that the error occurred at a rate of 75%. The most common errors were 1) Press the selection tab instead of scrolling to specify the period of illness. 2) Press letters or word that says How long have you had this symptom, which they could not and 3) Did not choose specialist doctor as specified.

Task 2 (Find articles about an illness) had the lowest error rate of 20 percent. Table 3 shows details of effectiveness testing results

Table 3: Effectiveness in terms of success and failure rate

Task	Perform without error n (%)	Need assistance n (%)	Failed to complete task or perform with error n (%)
Task 1: Register to the application for user account	11 (55%)	5 (25%)	4 (20%)
Task 2: Find articles about an illness	19 (95%)	0 (0%)	1 (5%)
Task 3: Find a specialist doctor for consultation	10 (50%)	2 (10%)	8 (40%)
Task 4: Edit user's profile	12 (60%)	4 (20%)	4 (20%)
Task 5: Find and try to order medicine	16 (80%)	3 (15%)	1 (5%)

Efficiency

The average work duration per person was 22 minutes 55 seconds, ranging between 11–39 minutes. Task 3 was the task that took the longest time to finish. This is coherent with the effectiveness testing result, which showed that Task 3 had the highest error rate. Task 2 (Find articles about an illness) was the least time-consuming task. Besides, according to the effectiveness result, it also had the lowest error rate.

Table 4: Average time spent to complete each task

Time per task (mins)	Task 1	Task 2	Task 3	Task 4	Task 5
Mean (SD)	6.10 (2.92)	2.25 (1.16)	6.20 (4.12)	3.90 (1.33)	4.10 (2.15)
Range	2 - 12	1 - 6	1 - 19	2 - 6	1 - 9

Satisfaction

The average satisfaction score was 31.50, which was lower than the expected benchmark of 68. In other words, satisfaction score of the application ranked by the participants was in 'not acceptable' range of the SUS (see Figure 1). This indicates that the older adults were not satisfied with the application.

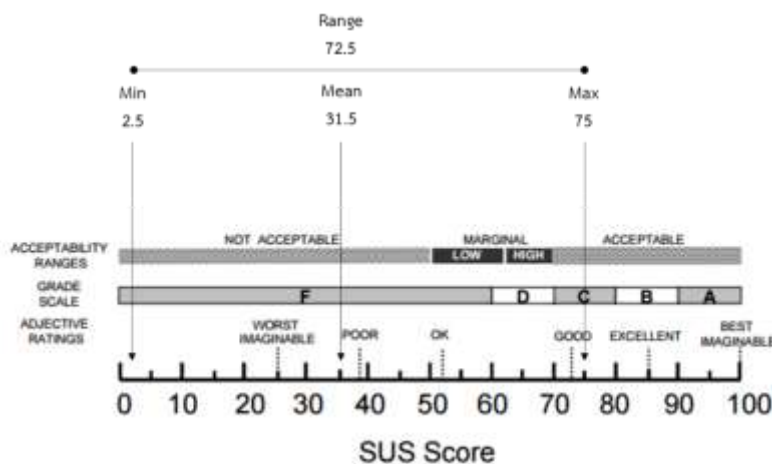


Figure 1: Satisfaction score rated by the participants on the system usability scale

Next subsection, interpretation from the think-aloud records and in-depth interviews is presented to elaborate the reasons the older adults found the application unsatisfactory.

Usability Issues Identified from the Think-Aloud session and In-depth interviews

Why have the older adults not used the application?

80% of the participants had never heard of the application. However, although they could see the potential benefits of the application, they showed no interest in adopting and using it in the future as they have found that the application was too difficult and too complex for them. Some of the participants perceived their educational background, IT skill, memory, and eyesight as barriers to the use of the application.

Learnability

The participants found that the application was difficult to use, complex, involving many steps, and confusing. Besides, some of them were unfamiliar with navigating the application by themselves and required assistance while trying to use the application. According to one of the participants, “The app is too difficult to understand. I would need a helper to sit next to me and tell me what to do, because this [the application] is too complex.” (Female #2)

Efficiency

The participants felt that they could finish the required tasks slowly as it took times for them to try to understand how to use and how to find things within the application. Several applications mentioned that the application should provide a set of instructions or how-to for older adults, reduce unnecessary steps in the application, and redesign buttons, menus, and wordings that could convey better “what the button or menu is for”.

Memorability

The participants found that it was difficult to memorize the basic instructions provided by the researcher. Some participants did ask for assistance during the usability testing session; however “despite the hints [provided by the researcher], I still cannot recall, and I don’t know what to do next” (Male #5).

However, most participants pointed to their own memorability due to their age instead of the complexity of the application.

Error

During the usability testing session, some participants were able to correct their mistakes, while those who could not mentioned that because they did not understand how to use the application, they were not able to locate a menu or an action required for a given task. In addition, when the application displayed an error message, most participants closed the message box right away without reading it. They, then, did not know what went wrong and were not able to solve the problem. This affected the participants’ emotion, making them frustrated and not wanting to complete a task.

Satisfaction

Satisfaction was mentioned in terms of perceived benefits. After the usability testing session, some participants were pleased with the convenience provided by the application. The application enabled them to learn about their illness and talk to a doctor without having to go to hospital. One of the participants mentioned that “it [the application] is more beneficial than I think it would be. It allows us to search and read about disease, symptoms, and cures. If we can’t meet a doctor, we can read about the illness first.” (Female #9)

Factors affecting the usability perceived by the older adults

Functionalities and attributes of the application that could facilitate or impede the use of the application by the older adults can be grouped into three dimensions.

1) Usage: a major barrier to the use of the application perceived by the older adults was the difficulty and complexity of the application. Navigation and menu should be redesigned to be more straightforward, short and simple. A wizard to briefly introduce the key features and how to start using the application would be of much help to the older adults. Besides, technical terms and English made it difficult for the users to understand and use the application.

2) Design: most of the users found that the design of icons, menus, and buttons were not designed for them. People at their age usually had eyesight problems. Thus, size of icons, buttons, menus, fonts, and symbols should be made bigger. Colors and highlights should be carefully applied; dark and solid colors were preferred to the light and pale colors. Usage of Buddhist calendar was more familiar to the older adults than the B.C. calendar; choices of calendar systems should be provided.

3) Interaction: the usability testing session has shown that the participants with different IT background perceived and interacted differently with the application. In other words, IT background, including skills, was found influencing attitudes and interaction of the older adults with the application.

CONCLUSION

This research identifies major reasons the older adults have not used the mobile healthcare application. The cause is often due to the fact that the older adults have never heard of the mobile healthcare application before. Besides, they are afraid of making mistakes and found the application is too difficult to use. The interface design was another key issue mentioned by the older adults. They did not feel satisfied after the trials. Demographically, gender, age, and IT experiences were mentioned as relevant factors influencing the older adults’ attitudes towards the application.

Factors that hinder usability include visual aesthetic design factors such as font size, font color, and layout, difficulty in understanding factor. Elderly people are confused and often misinterpret the meaning of buttons or menus, causing errors during use, and interaction and navigation factors. This factor is mainly caused by too many and too complex steps.

Factors contributing to usability include ease of use. The application is easy to use, friendly, uncomplicated, few steps and meaningful will make using application easier. The use of images will greatly facilitate the elderly. In addition, processes that are consistent with daily life or referring to a doctor visit at the hospital will further enhance the understanding of the application to the next level.

However, this study uses a small sample population so the conclusions may not cover the entire population, and because it is a short-term study, the test participant did not use all of functions available which might significantly affect the overall satisfaction score after use. Another important limitation maybe in testing process. The number of errors can be misleading due to each task has different probability of error occurrence. Therefore, future research should expand to wider range of population and more diverse areas. Allow test participants some time to use to see result, to see the number of active users as well as inactive users and why. And compare the telemedicine applications available in the market today to find out if an application with less functionality is suitable for a real user.

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APPENDIX A: Questions in the System Usability Scale (SUS) Questionnaire.

1. I think I would want to use this application often
2. I found the application was made unnecessarily complex
3. I think this application is easy-to-use
4. I think I would need a technical support to be able to use this application
5. I found several functions of the application work well
6. I think functionalities within this application are not coherent
7. I think most people will be able to learn quickly and able to use the application soon after they have started
8. I think this application is difficult/complex
9. I am confident while using this application
10. I need to learn so many things before I can start using the application

Using artificial intelligence to study the impact of jobseekers' Facebook profile pictures on recruiters' interview decision

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ABSTRACT

Previous research has shown that jobseekers' information on Facebook influences recruiters' decision-making. This study extends previous research by using artificial intelligence to study the impact of jobseekers' Facebook profile pictures sharing on recruiters' decision-making during the pandemics.

For most people, Facebook is an integral part of everyday life. Facebook allows its jobseekers to interact with passive and active jobseekers in a low-cost and relatively easy way. Facebook is a useful business tool for companies and individuals to promote their brands, personal image and personality types. Jobseekers are one of the largest groups of Facebook jobseekers. Smart business recruiters and recruiters are using many tools and strategies to find the best Jobseekers on Facebook. Jobseekers' Facebook profile pictures sharing has been a topic of interest to searchers in recent years.

This study collected data from 500 Jobseekers' Facebook profile pictures and recruited 50 recruiters. The results show that the jobseekers' Facebook profile pictures are positively correlated with recruiters' interview decisions during the pandemic. This study uses artificial intelligence to judge the personality traits of jobseekers based on Facebook profile pictures and examines the impact of jobseekers' Facebook profile pictures and recruiters' interview decisions.

Keywords: Facebook profile picture, interview decision, personality trait, artificial intelligence.

INTRODUCTION

Past researchers have found that people with high work conscientiousness always try their best to do their best and have a serious and responsible work attitude. The higher the conscientiousness, the better the work performance. (Barrick & Mount, 1991), and this study extends the validation of the previous study, which means that when recruiters judge jobseekers, they will perform well when they are considered to be highly conscientious. In this study, the recruiters are expected to perceive that the jobseekers' good performance in the future will lead to more interview opportunities, and even obtain the recruiters' decision-making for employment. Therefore, this study uses artificial intelligence to study the big five personality traits of jobseekers' Facebook profile pictures and the impact of jobseekers' Facebook profile pictures and recruiters' decision-making of interviews during the pandemics.

The University of Pennsylvania study concluded that open or neurotic Facebook jobseekers tend to post fewer pictures of people, and they tend not to express positive emotions when people are present, although the aesthetic quality of the pictures is higher for openness and for neuroticism lower. Conscientious, easy-going, outgoing Facebook jobseekers prefer pictures with at least one face, often showing positive emotions through facial expressions, but conscientious jobseekers seem to be following the rules and posting the general definition of a profile picture: a picture of a face expressing all the most positive emotion among big five personality traits.

Another study from York University in Toronto found that people were more likely to be friends with people whose Facebook profile pictures showed wide eyes, oval faces, smiles and brown hair, The Washington Post reported. Also, pictures on Facebook who wear sweaters are seen as more approachable - perhaps it reminds them of Mister Rogers. People were less likely to like pictures on Facebook with neutral or negative facial expressions, black or short hair, and hats or sunglasses, variables that apply to introversion, neuroticism, and unhappiness.

Jobseekers are one of the largest groups of Facebook jobseekers. Smart business recruiters and recruiters are using many tools and strategies to find the best Jobseekers on Facebook. Smart business recruiters and recruiters are using many tools and strategies to find the best Jobseekers on Facebook. Facebook profile pictures shared by jobseekers has been a topic of interest to searchers in recent years. Based on the above motivations, this study uses artificial intelligence to examine the impact of Jobseeker personality traits on Facebook Jobseeker photo sharing and interviewer decision-making during the pandemic. Therefore, by collecting the relevant literature of previous scholars and using the field method to conduct an empirical study on

the Facebook profile pictures of Jobseekers in the real workplace, it is hoped that the hypothesis put forward by the research can be supported.

The rest of this paper is arranged as follows. Section 2 reviews previous articles and theories on the big five personality traits and presents a research scenario of interviewer decision-making during the pandemic by pictures shared by Jobseekers on Facebook. Section 3 describes research methods that explore the impact of jobseekers' Facebook photo sharing on interviewer decision-making during the pandemic. Section 4 presents the results of running the research model, and Section 5 discusses the results. Section 6 summarizes all the work of the study.

LITERATURE REVIEW

Social networking platforms like Facebook are venues for self-presentation, and uploaded pictures are one of the main self-presentations (Buffardi & Campbell, 2008). Facebook is now an important communication and relationship platform. Individuals use Facebook for entertainment, communication, relationship maintenance, and self-expression (Park & Lee, 2014). Facebook jobseekers can show others their self-images by posting pictures, describing interests and comments. These portrayed self-images remain a good indicator of their underlying personality (Shen, Brdiczka, & Liu, 2015). Despite the variety of self-images posted on Facebook, many of its jobseekers seem to be trying to project a socially needed self (Zhao, Grasmuck, & Martin, 2008).

Facebook users can present themselves with explicit statements, such as their interests, but they seem to rely more on implicit information in posted pictures (Tifferet & Vilnai-Yavetz, 2014; Zhao et al., 2008). Other similar studies can be found in the literature. Higher narcissistic impression ratings correlate with more attractive, sexy, and self-promoting pictures in owner Facebook (Buffardi & Campbell, 2008); observers are extroverted when photographing targets with restricted poses and facial expressions. Sexual judgments are accurate (Naumann, Vazire, Rentfrow, & Gosling, 2009); for example, judgments based on Facebook profile pictures are highly correlated with ratings of personality traits based on full information pages (Ivcevic & Ambady, 2012); Kuo and Tang (2014) asserted that the number of pictures was positively correlated with extraversion and negatively correlated with agreeableness and emotional stability. Gosling and colleagues (2011) argue that extroverted Facebook users are more likely to upload more pictures than introverted jobseekers, which seems to extend their offline personalities to the realm of online social networking sites.

Researchers agree that most personality trait measures can be categorized according to the big five model of personality traits (Barrick & Mount, 1991; Tett & Burnett, 2003; Flaherty & Moss, 2009; O'Connell & Sheikh, 2011). Personality trait inference using Facebook is now one of the hot topics in the literature. There are studies looking at Facebook usage habits based on user personality traits. In psychology, the five main characteristics that define human personality traits are known as the big five (Goldberg 1992). These five personality traits are Agreeableness, Conscientiousness, Extraversion, Neuroticism, and Openness. In the literature, studies have used linguistic features extracted from written or spoken texts to predict big five personality traits. Personality trait prediction on Facebook is a very popular and recent topic. Jobseekers on Facebook tell recruiters their personality traits as the content of their profile pictures they share. In this study, these five personality traits of jobseekers' Facebook profile pictures can be assessed by artificial intelligence. These five personality traits are explained in detail below.

Agreeableness is a personality trait associated with social harmony and cooperation. Agreeable people choose pastel, messy, and less aesthetically pleasing pictures, although they do display positive emotions, such as happiness. Agreeableness tends to be cooperative, helpful, and interpersonal success (Barrick & Mount, 1991), and is positively correlated with posting on Facebook to communicate and connect with others. Their use of Facebook to communicate may inspire them to update their social activities and important relationships more frequently. Agreeable people are most often tagged in other people's pictures. A 2012 study titled "Personality and Patterns of Facebook Use" found that the higher a person ranks on personality agreeableness, the more likely that person is to be tagged in Facebook profile pictures posted by others. Since agreeable people tend to be warm and friendly and less competitive, it's no surprise that their friends like to take lighthearted pictures with them and share them on Facebook.

Conscientiousness is a personality trait associated with order, planned behavior, and self-discipline. Conscientious people choose colorful, natural, bright images where they smile, and generally look happy. Tends to be organized and dependable, displays self-discipline, is conscientious, aims for achievement, and prefers planned rather than spontaneous behavior. A high degree of conscientiousness is often seen as stubborn and obsessive. Conscientious people are more likely to have children, or the mere experience of having children increases one's sense of responsibility (Barrick & Mount, 1991).. If that's the case, conscientious people may post more about their children simply because they're more likely to have children. A conscientious person will carefully organize the pictures. They are self-disciplined hard workers who spend the least amount of time on Facebook. A 2014 study published in *Computers in Human Behavior* reported that when conscientious people use Facebook, they do so in a very methodical manner. For example, they might create neat folders to help methodically share their pictures with friends and family.

Extraversion is a personality trait associated with high energy, positive emotions, self-confidence, social and propensity to seek stimulation in the company of others, and talkativeness (Moore and McElroy 2012). Highly extroverted people are often seen as attention-seeking and bossy. According to a 2014 study called "Facebook Personality Traits and Self-Representation,"

extroverts are more socially active on social media. Research has found that extroverts use the like button more frequently, upload more pictures and update their status more frequently than introverts. Extroverts typically opt for a clear, colorful avatar featuring multiple young-looking people, often without glasses (this is associated with introverts). Extroverts are more likely to post about social activities and everyday life, mainly due to their desire to use Facebook as a tool to communicate and socialize with others on Facebook. People who use Facebook frequently and have more Facebook friends.

Neuroticism is a personality trait associated with negative emotions and emotionally unstable experiences, so neurotic people often display simple, colorless images with negatively colored emotions (John et al.2008; Smith et al. 2014). Facial expressions often lack openness, including glasses, although neurotic people often choose profile images without visible faces. Neurotic people tend to have the most pictures per album. The researchers believe this stems from their desire to actively present themselves. They may use the photo to try to appear happier and to show that they are able to keep up with their friends. However, the behavior of highly neurotic people tends to change over time. They may mimic their friends' behavior on Facebook to seek acceptance and reduce loneliness. Neurotic people mostly post pictures. A 2014 study titled "Capturing Personality from Facebook profile pictures and Photo-Related Activity" found that highly neurotic people, those most prone to stress and anxiety, seek acceptance by posting pictures. Because neurotic people have difficulties with communication and social skills, researchers believe they use Facebook profile pictures as a way of expressing themselves. Also, Facebook profile pictures are less controversial than comments - which can cause them a lot of anxiety while waiting for other people to respond.

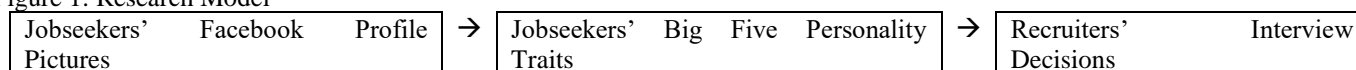
Openness is a personality trait associated with sub-traits divided into "Intelligence" and "Experience Openness". Open-minded people tend to choose less colorful but appealing pictures with less contrast, sharpness, saturation, and blur. Additionally, open people tend to show a wider range of emotions in their profile pictures. A high degree of openness can be seen as unpredictable or lacking focus. In addition, people with high openness are said to pursue self-actualization by seeking intense, euphoric experiences, such as skydiving, living abroad, gambling (Barrick & Mount, 1991). Openness is positively correlated with Facebook usage and tends to be creative, knowledgeable, and curious on Facebook. A 2010 study called "Social Network Use and Personality" found that people who are open - described as artistic, imaginative, and creative - use the most features on Facebook and are most likely to complete the personal information section. When communicating with specific friends, they tend to post more "wall messages". Those who are highly open are more likely to post updates about their intellectual interests and use Facebook to find information, and this information-seeking motivation explains their tendency to post on such topics.

RESEARCH MODEL AND HYPOTHESIS

Research Model

Through the above literature, this study’s research framework shown below, we introduced jobseekers’ big 5 personality traits as a mediator and show how it affects the relationship between the independent variable (jobseekers’ Facebook profile pictures) and the dependent variable (recruiters’ interview decisions). Here is our research framework where there is a mediator was introduced:

Figure 1: Research Model



Hypotheses

Through the above literature reviews and research framework, this research’s hypotheses have summarized in Table 3-1. This study proposes the following hypothesis:

Table 1: Hypothesis

Hypothesis	Description
Hypothesis 1	Jobseeker’s agreeableness personality trait mediates the relationship between Jobseeker’s Facebook profile pictures and recruiter’s interview decision
Hypothesis 2	Jobseeker’s conscientiousness personality trait mediates the relationship between Jobseeker’s Facebook profile pictures and recruiter’s interview decision
Hypothesis 3	Jobseeker’s extraversion personality trait mediates the relationship between jobseeker’s Facebook profile pictures and recruiter’s interview decision.
Hypothesis 4	Jobseeker’s neuroticism personality trait mediates the relationship between jobseeker’s Facebook profile pictures and recruiter’s interview decision
Hypothesis 5	Jobseeker’s openness personality trait mediates the relationship between jobseeker’s Facebook profile pictures and recruiter’s interview decision

Source: This study.

Research Sample and Survey Process

The study recruited 500 jobseekers between the ages of 21 and 55 and used artificial intelligence to judge 500 jobseekers’ big five personal traits based on their Facebook profile pictures. The artificial intelligence for this study uses a short-form inventory of 10 for big five personality traits (BFSI-10). View jobseekers’ Facebook profile pictures as someone:

- (1) is outgoing, sociable
- (2) tends to find fault with others
- (3) does a thorough job
- (4) gets nervous easily
- (5) has an active imagination
- (6) is enthusiastic
- (7) is critical
- (8) is self-disciplined
- (9) is easily upset
- (10) is open to new experiences

This study conducted interviews with 50 recruiters to understand the importance of a jobseeker's Facebook photo in interview decisions. After recruiters agreed to participate in the study, we asked recruiters to study the personality traits of 500 jobseekers to decide whether to interview. Participants in this research consisted of 50 recruiters who have solid experiences in interviewing and Facebook profile pictures screening, each of 50 recruiters will be led into a meeting room and received an information packet that included a series of 10 jobseekers Facebook profile pictures and one corresponding questionnaire about each jobseeker's big five personality traits are listed. Each recruiter was invited to randomly review 10 jobseekers' Facebook profile pictures and will fill out a survey of interview decisions for each jobseeker. Of those participants, 50 recruiters completed 500 survey questionnaires. We used Higgins and Judge (2004)'s "Overall, I would/positively evaluate these applicants" item to measure recruiters' interview decisions for each jobseeker whose personality traits based on their Facebook profile pictures are analyzed by this study of artificial intelligence. Recruiters were asked to rate their interview decisions about jobseekers using a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=neither agree, 4=agree, 5=strongly agree).

RESULTS

The total numbers of Facebook jobseekers were 500. Of the sample, 64% of the respondents were males and 36% were females. As for age, 10% of the sample below 25 years old, 31% of the sample fell between the ages of 26 and 30, 23% between 31 and 35, 17% between 36 and 40, 10% between 41 and 45, 10% between 41 and 45, 5% between 46 and 50, and 4% between 51 and 55.

Table 2: Jobseekers information.

Item	Description	Number	Percentage
Gender	1. Male	318	64%
	2. Female	182	36%
Age	1. 21-25	49	10%
	2. 26-30	155	31%
	3. 31-35	113	23%
	4. 36-40	84	17%
	5. 41-45	51	10%
	6. 46-50	27	5%
	7. 51-55	21	4%

Source: This study.

The means, standard deviations and intercorrelations of all variables list in TABLE 4-2. TABLE 4-2 lists the average value, variables, standard deviation and correlation coefficient of the research. The diagonal value in the matrix is the reliability coefficient (Cronbach's α), and the value outside the diagonal is the correlation coefficient between the variables. The two-tail verification in the correlation analysis using Pearson (Pearson) has significantly affected the correlation between variables, and the larger the coefficient, the greater the correlation between the variables.

Table 3: The Means, Standard Deviations and Intercorrelations of All Variables

Variable	M	SD	Profile Pictures
Profile pictures	4.58	.68	—
Agreeableness	4.16	1.18	.60**
Conscientiousness	3.71	1.09	.49**
Extraversion	3.79	1.26	.52**
Neuroticism	2.02	1.10	-.41**
Openness	4.01	1.18	.60**
Interview decision	3.78	1.12	.57**

Source: This study.

Notes: aValues on the diagonal are Cronbach's alpha *p < .05. **p < .01

Table 4: Presents the research results of this study.

Hypothesis	Description
Hypothesis 1	Jobseeker's agreeableness personality trait mediates the relationship between Jobseeker's Facebook profile pictures and recruiter's interview decision Result: Partially Supported
Hypothesis 2	Jobseeker's conscientiousness personality trait mediates the relationship between Jobseeker's Facebook profile pictures and recruiter's interview decision Result: Partially Supported
Hypothesis 3	Jobseeker's extraversion personality trait mediates the relationship between jobseeker's Facebook profile pictures and recruiter's interview decision. Result: Partially Supported
Hypothesis 4	Jobseeker's neuroticism personality trait mediates the relationship between jobseeker's Facebook profile pictures and recruiter's interview decision Result: Partially Supported
Hypothesis 5	Jobseeker's openness personality trait mediates the relationship between jobseeker's Facebook profile pictures and recruiter's interview decision Result: Partially Supported

Source: This study.

All hypotheses are listed above, and results of all hypotheses are partially supported.

Agreeableness is characterized by social harmony and cooperation. Agreeable jobseekers choose soft, cluttered, less aesthetically pleasing images of their pictures sharing than their counterparts, though they do display positive emotions, like joy. Agreeableness tends to be cooperative, helpful, and interpersonal success (Barrick & Mount, 1991), and is positively associated with posting on Facebook to communicate and connect with others. Their use of Facebook to communicate may inspire their frequent updates on contacts, social events, affairs, deals, associations, and important relationships. It was found that the higher a person ranks on the Agreeableness Personality Scale (Bachrach 2012), the more likely that person is to be tagged in Facebook profile pictures posted by others. The results of this study showed agreeable jobseekers are most often tagged in other people's pictures. Since agreeable jobseekers tend to be warm, friendly, and less aggressive, it's no surprise that their friends like to take lighthearted pictures with them and share them on Facebook.

Conscientiousness is a personality trait associated with order, planned behavior, and self-discipline. Conscientious job seekers choose colorful, natural, bright images of pictures to share where they are smiling and generally looking happy. Jobseekers with a highly conscientious personality trait are hardworking and highly motivated to succeed in their chosen field. They care about the impact of their actions on others, enjoy working as planned, and fulfilling personal and professional responsibilities. Low levels of conscientiousness generally reflect a lighter attitude to life, less organization, and more spontaneous behavior. The researchers initially hypothesized that conscientious Facebook jobseekers were more likely to post pictures of status updates discussing safety topics, non-controversial topics that don't cause disagreements with friends. However, the results of this study do not reflect this theory. Instead, the results showed a link between conscientiousness and job seekers posting more status-update pictures related to their children. This study offers a possible explanation for pictures posting. Conscientious jobseekers may update pictures of their children's status for purposes other than communicating with friends.

Extraversion is a trait marked by engagement with the outside world. Extraverted job seekers often select sharp, colorful profile images of pictures that contain multiple, young-looking people, generally not wearing glasses (which is associated with introverts). Extraversion is one of the most discussed and researched personality traits, and is one of the big five factors. The trait also features in other theories of personality. Extraverted jobseekers are sociable and outgoing, often talkative and confident when meeting new people. Extraverted job seekers often feel most comfortable when surrounded by others. This study offers a possible explanation for jobseekers with a low level of this trait - introverts - enjoy their own company, and thrive in smaller groups of close friends.

Neuroticism is associated with the experience of negative emotions and emotional instability, and thus neurotic jobseekers generally display simple, un-colorful images of pictures with negative color emotions. Facial expressions often lack openness, and include glasses, though neurotic people often choose profile images without visible faces. His study found that jobseekers with high levels of reported neuroticism tended to use Facebook as a means of obtaining validation. Such job seekers may post statuses on the social network as a way of receiving support from friends for their feelings and opinions when they are feeling isolated in their views. Narcissistic job seekers tend to show more interest in themselves compared to those around them. Jobseekers are more concerned about their self-presentation and worry what others may think of them. As a result, narcissists may be considered to be vain or selfish by their peers. Similarly, to jobseekers with high levels of neuroticism, narcissists were found to use Facebook as a tool for obtaining validation and assurance from others. Narcissists tended to post more status updates relating to their personal achievements in life. They shared details of their diets and fitness routines more regularly than other jobseekers. This study found that narcissists reported receiving more likes and comments from friends in response to

their posts. The researchers suggest that this may be due to the topics that narcissists discuss in their posts being more popular than those that others share.

Openness is separated into the sub-traits 'Intellect' and 'Openness to Experience'. Open people tend to choose appealing though less colorful images of pictures, with increased contrast, sharpness, saturation and less blur. Additionally, open people tend to display a wider range of emotions in their profile pictures. Openness is associated with an enjoyment of new and unfamiliar experiences. Jobseekers with a high openness score will often like to travel and embark on adventures. Jobseekers are more open to unconventional ideas and will often have a keen interest in the arts. The study found that jobseekers with an open personality trait post more status updates relating to intellectual topics. Jobseekers use Facebook more as a source of information -news, ideas and opinions, rather than as a way of connecting socially with other jobseekers. "People high in openness may write updates about current events, research, or their political views for the purpose of sharing impersonal information rather than for socializing," the authors found.

DISCUSSION

This study's findings were about the way jobseekers' Facebook profile pictures were used to assess personality traits. In a previous study (Ivcevic & Ambady, 2012), judges were asked to base on an examination of Facebook profile pictures to rate Facebook jobseekers' personality traits. If judges are not well trained, they will not be able to obtain accurate personality assessments. Rather than using judges' subjective evaluations, this study uses artificial intelligence to judge jobseekers' personality traits based on their Facebook profile pictures and investigate the relationship between jobseekers' Facebook profile pictures and recruiters' interview decisions.

The results of this study showed that each of the big five personality traits was a good predictor of certain photo categories, as shown below:

Agreeable Jobseekers who are cooperative and get along well with others. There are few people who don't like the amiable Jobseeker, and the agreeable jobseeker is the last person to make a fuss on Facebook. This can be seen in jobseekers' profile pictures, which are bright and vibrant, perhaps with a beaming buddy or with quirky filters. Agreeable jobseekers may have some blurry pictures, but everyone is likely to be smiling in their pictures.

Jobseekers who have a conscientious personality love taking selfies. Jobseekers with conscientious personality traits are more self-disciplined and like to adapt to society's expectations and go with the flow. Conscientious jobseekers only show their face in their profile photo, and they may look slightly older than they appear in the profile photo.

Jobseekers with extrovert personality traits, their pictures are bumping with their friends. Extrovert jobseekers will have the most colorful and compelling profile pictures, reflecting their open and confident personalities. Extrovert jobseekers love to go out and feel your best when everyone is looking at you, talking about you, or both. Extroverted Jobseekers often choose an avatar that makes them look younger, and may use a photo of a lot of other people.

Neurotic jobseekers are likely to be negative, unstable, and easily overwhelmed. When something goes wrong, neurotic jobseekers can be the first one to get stuck and screw things up disproportionately. This is reflected in neurotic jobseekers' profile pictures with darker colors and negative facial expressions.

Open Jobseekers' profile pictures are more vibrant and colorful, and the jobseekers with an open personality trait will probably be smiling in their snap. Jobseekers with an open personality are keen on new experiences, not keen on saying no to things, and have some strong beliefs. Open Jobseekers are always trying to make each day fulfilling. This can be seen in darker profile pictures that don't necessarily focus on faces, and instead, public jobseekers' profile pictures may reflect their rebellious personality traits.

Unlike previous studies, this study focuses on jobseekers' Facebook profile pictures categories, rather than Facebook usage and behavior, and finds that jobseekers' Facebook profile pictures can well reflect jobseekers' personality traits. This study's findings also expand literature into new areas that explore the underlying tendencies of Facebook jobseekers.

IMPLICATION

Previous studies (Harold, McFarland, and Weekly, 2006) have not explored the relationship between jobseekers' Facebook profile pictures and influencing recruiters' interview decisions. This study helps to automate judgment through artificial intelligence, examining jobseekers' Facebook avatars and the relationship between recruiters' interview decisions and recruiters' perceptions of jobseekers' personality traits (easy-going, conscientious, extroverted, neurotic, open-minded) relation.

This study further explores the impact of jobseekers' Facebook profile pictures on interview decisions. There is little relationship between officials agreeing to interview or not. Most past research has shown that past behavior is a predictor of future behavior. Recruiters can predict future behavior, such as work experience, activities, based on past behavior on a jobseeker's Facebook profile. The results of this study are consistent with this statement. Past Facebook related research has mostly employed an experimental approach; this study uses actual Facebook in real, large companies for an on-the-spot

approach. The results of the study found that recruiters perceived jobseekers as easygoing, outgoing personality traits when their Facebook profile pictures included more Facebook friends. When Jobseekers report more friends on Facebook, recruiters see jobseekers as conscientious personality traits. Correspondingly, interview decisions by recruiters have increased.

In previous studies, in terms of personality traits, recruiters used Facebook avatars to judge the personality traits of jobseekers, mainly discussing diligence and caution (Cole et al., 2003, 2004), but this study is different from the research focus of previous studies, this study used AI to auto judge jobseekers' personality traits basing on their Facebook profile pictures and found that the relationship between recruiters' perceptions of jobseekers' personality traits and recruiters' interview decisions has received attention (Dunn et al., 1995; Caldwell & Burger, 1998). Therefore, this study explores the relationship between the independent variable (jobseekers' Facebook profile pictures) and the dependent variable (recruiters interview decisions) influenced by a mediating factor (jobseekers' big five personality traits).

LIMITATION AND FUTURE RESEARCH

Limitations of this study, while we would like to take the Facebook shortcut, many Jobseekers have Facebook profiles and profile pictures limited to those accessible to the public. And some jobseekers are reluctant to share their Facebook information and profile pictures with recruiters and hiring companies.

This study found that the big five personality traits of jobseekers play a mediating role between jobseekers' Facebook profile pictures and recruiters' interview decisions, and future research can study the role of jobseekers' big five personality traits in Jobseekers' Facebook profiles and final hiring decisions. The future research could continue to contact the hiring manager to see when the company has ended the screening process and ask the hiring manager after a period of time if they have finally made a decision to hire the jobseekers and then see if the jobseekers agree to join. company or not.

Facebook is the leader in social media, focusing on social networking and massagers, recently Facebook usage among teens dropped from 71% to 51%, and it's interesting to see how Facebook user demographics have changed. Many companies have regularly used LinkedIn to create company pages, post job openings, attract talent, initiate and nurture conversations with customers and prospects, generate leads, and promote other social media. The Future research may extend jobseekers information to LinkedIn and Instagram.

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Using text analytics to discover organizational congruences: A study of the Thai IT industry

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ABSTRACT

Organizational congruence is a leading indicator for organizational adaptation and increasing relevant in technological disruptive environments. However, the congruence perspective is often investigated through another lens. Information technology (IT) literature is less familiar with this perspective. This study aims to raise awareness of the perspective among IT literature by strictly investigating constructs under the perspective. It postulated an investigation akin to a measure development under the congruence perspective. Data was collected from Thai IT industry and a combination of computer-aided text analysis and traditional measure development were implemented. The data was preprocessed to ensure high quality and entered to measure modeling techniques. The results unveil four organizational congruence constructs. Three are first-level constructs: strategy consensus, operational congruence, and competitive congruence. One is second-level construct: organizational ambidexterity. Implications of this discovery are discussed. Limitations and future directions are recognized in the last section.

Keywords: Congruence perspective, computer-aided text analysis (CATA), strategic consensus, ambidexterity.

INTRODUCTION

Congruence perspective for organization theorizes that organizational performance is the result of close interrelationships among structural and environmental variables (Randolph & Dess, 1984). The closer the relationships align, the higher the performance becomes. This perspective is often demonstrated by contingency studies. Variables are modeled to “fit” according to their theoretical relationships. This “fitting” is used to justify as the demonstration of congruence. As a result, congruence and contingency are often interchangeably used (Sarta *et al.*, 2021). However, Fry & Smith (1987) point out that both are different concepts, and they should be recognized as such. Congruence concerns the nature of co-occurrence of variables within a defined system. Contingency concerns a particular configuration of the variables at certain state of the system. “Congruence is a necessary but not sufficient condition for contingency” (Fry & Smith, 1987, p. 123). A group of variables may always occur together in a defined system, but their configuration depends on a state of the system. Information technology (IT) literature at organizational level is mostly familiar with contingency perspective. IT adoption in organization studies theorize match between the artifact adoption and particular organizational features (e.g., Zapadka *et al.*, 2022). IT alignment studies posit fit between IT related strategic choice and set of organizational characteristics (e.g., Feng *et al.*, 2021). IT implementation studies focus on close alignment between the implementation and organizational process variables (e.g., Yang *et al.*, 2019). These studies are all based on the contingency perspective.

The current study aims to raise awareness of the congruence perspective among IT literature. It plans to discover organizational congruence emerged from co-occurrence and intercorrelate of variables without contingency theorization. The emergence of the congruence is independent of organization states. This discovery of organizational congruence advances congruence perspective in IT literature in many ways. First, the organizational congruence can be used in organizational adaptation studies. The adaptation is centered on minimization of incongruence (Sarta *et al.*, 2021). IT organizations operate in highly volatile environment. They need constant adjustments to stay relevant. Therefore, congruence can be examined and understood its effects on the adaptation. As a result, IT organization can appropriately adjust its structure and resources according to the effects. Second, the congruence captures multidimension and recognizes multi-constraints at organizational level (Larsen *et al.*, 2013). IT alignment studies through the lens of contingency may limit their implications because of the transitory nature of business states. Congruence perspective offers a less restricted view of the alignment. Therefore, its implications are arguably more generalizable. Last, IT organization must innovate to stay competitive. Contingency-based IT innovation studies largely postulate exploration and exploitation activities in terms of resource competition. However, exploration and exploitation are not mutually exclusive. IT organization can and should simultaneously exercise them (Hevner & Gregor, 2022). Congruence perspective can potentially offer more parsimonious solutions to IT innovation studies.

To accomplish its aim, this study conceptualizes the discovery of organizational congruence as a measure development. It, therefore, follows general steps for measure development and layouts each section according to the steps. Immediate next section is theoretical background with the focus to give theoretical underpinning the congruence and its measure. The following section layout details of data collection, preparation, and congruence indicator calculations. Then, the indicators are used in exploratory factor analysis and confirmatory factor analysis. This section discusses the emergence of the congruence constructs from the analyses. This study ends with the discussion, limitation, and future direction.

THEORY DEVELOPMENT

Organizational congruence

Organizational congruence is pattern of co-interrelationship among organizational variables (Sarta et al., 2021). It can be classified into internal and external. Internal congruence is the pattern among variables under organization management (Farjoun & Fiss, 2022). The internal congruence is also known as internal consensus, internal fit, and internal alignment. Internal management pays close attention to this type of congruence. Activities under human resource management should be designed to achieve high congruence to benefit the organization (Delery & Gupta, 2016). These activities included recruitment, enrolment, and retention. Individual activity did not significantly lead to organizational performance by itself. However, they holistically helped improve the performance. Huesch (2013) found that resources and their deployment capabilities could individually affect the organizational performance in a highly specialized industry. This finding highlights the congruence perspective that the present of variables were more important than the states among variables. Benlian (2013) showed that perceptual congruence between internal IT service professionals and organization IT users was key to service's satisfaction. This result makes IT managers aware of the importance of service dimensions beyond the implementation of IT functional requirements.

External congruence happens among within and beyond organizational managed variables. External fit is also recognized as environmental fit, and external alignment. This type of congruence is vital to organization survival. Candi and Beltagui (2019) unveiled that the congruence between the adoption of high-technology equipment and external condition could result in higher innovation performance. Possessing the equipment and having implementation capabilities were important to the organization performance by themselves but to be successful among peers takes more than the equipment and implementation. Organization must take external condition into consideration. Yu et al. (2018) revealed that organizational capabilities should be co-evolution with the organizational environment. Sophisticated capabilities are less relevant when the environment is not complex. On the other hand, sophisticated capabilities are meaningful for organizational performance in complex environments. Therefore, organization do not have to over invest in its capabilities. Yamakawaa et al. (2011) presented evidence that co-alignment between organizational strategy and interorganizational relationships placed the organizational into a better performance category. Prior interorganizational studies mostly recognize the relationships as transactional fit. However, the interorganizational relationships were akin to organizational environment. Therefore, a holistic approach to the matter was more appropriated (Yamakawaa et al., 2011).

Both types of the congruence are essential to organizational adaptations. External congruence can be used as the metric for business model evolution (Climent & Haftor, 2021) and an appropriate amount of internal congruence help firm's ability to mobilize changes (Khanagha et al., 2018). Furthermore, the two types of congruence do not contradict each other (Miller, 1992; Climent & Haftor, 2021) This study finds no theoretical reason to limit itself to a particular type of congruence. Therefore, it pursues the discovery of both types of organizational congruence.

Discovering congruence

To discover congruence is to measure its manifestation. This study takes the stock from concept of "fit" as the beginning. Venkatraman (1989) proposed six types of fits. The types were classified using two axes. One axis was anchoring, and another was form-specificity. The first axis expressed degree of criterion dependence ranged from highly dependent to independent. The second axis spanned the degree of specificity among the variables from high to low. The most restricted type was "fit as moderation" and the most relaxed type was "fit as gestalts". The research suggested that number of variables under investigation tend to increase from the most restricted type to the most relaxed type. Zigurs & Buckland (1998) brought the six types of fit to the IT literature. They suggested that organizational congruence is "fit as gestalts" because this type of fit simultaneously takes multiple variables into account without specific criterion and across multiple organizational configurations. Lin (2014) demonstrated congruence through series of regression models. The researcher measured multiple stages of organizations and configurations. Multiple interaction terms were used to cover a variety of fits across 8 models. The fittings across multiple stages and configurations well expressed the concept of congruence. A recent study by Chatterjee et al. (2021) explored organizational congruence related to IT in terms of fit as covariation. The researchers argued that this type of fit is appropriate because all interested variables are observable within the organizations. They also proposed second-order congruence-based construct, which was emerged from the first-order constructs relationships. Confirmatory factor analysis evidenced congruences at both levels.

This study continues the line established by Chatterjee et al. (2021). Its interest is in discovering organizational congruence from co-interrelationships among targeted organizational observable variables. As a result, the congruence in this study is conceptualized as "fit as covariation". This study adopts computer-aided text analysis (CATA) in helping with the variable formulation. Chatterjee et al. (2021) gathered data from survey. It is argued that gathering survey data is more time and resource intensive than using CATA. The use of CATA in theoretical construct development is not recent. Short et al. (2010) revealed, at the time, that CATA has been used in the development for more than 25 years across areas in organizational study. CATA is superior to traditional survey-based measures that it is not suffered from subject participation rate and subject reliability. This superiority reduces random response error and transient error (McKenny et al., 2018). CATA work with data at its source and is ability to process high degree of sources (Short et al., 2010). However, CATA has its weakness in automated content selection. This study attempts to mitigate this weakness by getting humans to involve in the content selection. Therefore, the selection process is not entirely automated but semi-automated with human guidance.

Dimensions

This study chose to explore five organizational dimensions: organizational mission, organizational operation, competition, product and service, and organizational risk. The close interrelationships among these dimensions were used to formulate organizational congruence. These dimensions are selected to capture the three primary structural linkages of congruence perspective proposed by Randolph and Dess (1984). They are technology-structure, environment-structure, and environment-technology. Since this proposal, these linkages have been expanded and popularized in the congruence for organization literature.

The first dimension is the organizational mission. It sets strategic course for the organization. The mission gives reasons for an organization to exist in its competitive market. Management team carries out strategic planning to fulfill the mission statement. Organizational strategy resulted from the planning encapsulates all the primary structural linkages (Lin, 2014). An empirical investigation of high-technology organizations by Berbegal-Mirabent et al. (2020) revealed insights into the importance of mission statement for the organizational performance. The statement acted as the guide for strategic decision making. However, the guidance was not generally made obvious because it did not directly and specifically apply to a certain part of the organization. On the contrary, the positive effects on performance were created from holistic applications of the guidance throughout the organization. Everyone in every part of the organization was required to make aware and to appreciate the mission statement. This holistic view is akin to congruence.

The second dimension is organizational operation. This dimension is the engine of organization and touches the whole organization. Efficiency and effectiveness are the core focus of the dimension. This focus leads to organization's superior performance. Congruence between organizational operation and various organizational characteristics is behind the performance (David et al., 2002). The congruence does not naturally occur in the operation. Organization must be purposefully designed to accommodate the congruence. The result is the efficiency and effectiveness of the operation. Furthermore, congruence between organizational operation and environment was the fundamental for organizational dynamic capabilities in technology-oriented organization (Wheeler, 2002). Congruence perspective helps managers to see an integrated view of internal processes and external environment. This holistic view enables organization to stay adaptive in changing environment.

Competition is the third dimension. It interfaces an organization with its environment. Two basic tenants of competition are competitors and competitive market. The competitor is realized and clarified in the five-force framework (Porter, 1979). Competitors may involve an organization as current rivals or as market entrants. Either way could mean product alternatives, competitive barriers, or changes in organization's value chain. The result is an altered environment, which requires the organization to adapt. Competitive market drives strategic direction and decision makings. Based on congruence perspective, Roberts & Grover (2012) identify that IT oriented organizations are particularly vulnerable to the changes in competitive market. The changes signal shift in customer preference or emergence of new opportunity. Innovations are often needed to address the changes. Furthermore, competition involves an organization beyond the two tenants. Competitive activities define the industry where the organization belongs to. Traditional identity establishment by activities in certain industry becomes less than concrete. Industry boundary becomes less obvious. Especially, identity arose from interorganizational relationships may create appearance of multiple industries (Castañer & Oliveira, 2020). Congruence perspective offers a comprehensive view of competition.

The fourth dimension is products and services. This dimension connects not only to the organization but also to the environment. The congruence between product strategy and organizational characteristics is prerequisite to the performance (David et al., 2002). The researchers further revealed that effectiveness of the strategy depends on the organizational orientation to its environment. Products and services are also associated with technological innovation. Modern organization must actively strengthen both exploration and exploitation activities (Maclean et al., 2021). The exploration is for products and services innovations. The exploitation helps with technological solutions in production of products and services. These interrelationships with products and services characterize the congruence perspective.

Risk is the last dimension. Risks can be classified into internal and external. Both types can be managed to mitigate unfavorable consequences (Kaplan & Mikes, 2012). Nonetheless, they remain concerns for organizations because risk mitigations have never been perfect. Accounting for all threads is inconceivable. Having high degree of organizational congruence helps organization to navigate the future (Marinkovic et al., 2022). The congruence enables everyone in an organization to have common vision. Activities are synchronized and synergetic. The results are complementary. However, absence of risks in technology related organizations is undesirable. Risks encourage systematic feedback and innovation investment (Lucas et al., 2018). The feedback leads to organizational adaptation. Investment in innovation helps increase strategic options for the organization. Based-on the congruence perspective, risk introduces inconsistencies (Sillince, 2005). Organizational congruence is threatened by the inconsistencies. Organization adapts and invests to absorb the inconsistencies to be successful. Hence, risk is inseparable from the congruence perspective.

METHODOLOGY

This study adopted general natural language processing (NLP) pipeline for data preparation (Vajjala et al., 2020) and measure development for solution discovery (Heo & Kim, 2017; Tourky et al., 2020). NLP has the advantage that it can reliably process large volume of data. The raw data is annual reports of organizations in Thailand IT industry and was acquired from reputable

and reliable source, the Thai government agency website. This data was preprocessed to ensure quality. Content extraction and validation were among the preprocessing. The high-quality content was transformed into a suitable format for main processing. Term frequency-inverse document frequency (TF-IDF) feature extraction and cosine similarity calculations processed the data into a data matrix. This matrix was entered into exploratory factor analysis (EFA) to discover latent constructs. This discovery was used to specify confirmatory factor analysis (CFA). The emergent statistical parameters guided the CFA modeling and solution identification.

Sample and data collection

The primary purpose of this step is to acquire raw data from a reliable source. This study collected data from annual reports of listed Thai IT organizations. The list of 40 organizations was obtained from the technology sector of The Stock Exchange of Thailand. This sector includes electronic components and information & communication technology organizations. Annual reports of these organizations were downloaded from The Securities and Exchange Commission of Thailand website. There are many standardized versions of the annual reports. This study adopted the most recent version (i.e., 56-1), which has begun since 2013. This version is the most comprehensive with strategy and execution information. At the time of download in early 2022, a total number of 288 reports from 2013 to 2020 were available on the website. Less than 10% of the 2021 reports were available. The number of downloaded reports was amount to 90% of the expected number (i.e., 288/320). There were 222 PDF and 66 MS-Word files.

Data preparation

This step focuses on the preparation of high-quality text data. Visual examination of content inside the documents revealed that the content was written in Thai language. A small number of English words were occasionally used with their Thai counterparts when the English words were borrowed into the Thai language. This revelation is not out of the ordinary because all organizations were Thai, and the reports were done according to the standard of Securities and Exchange Commission of Thailand.

The goal of preparation is to have access to text data as its publisher's intended. The sixty-six MS-Word files allowed unrestricted access to their contents via MS-Word program. Therefore, the contents of these files were considered high quality. No future processing was needed. The two hundred twenty-two PDF files presented challenges. The contents were accessible in read-only mode. To freely access text contents of the PDF files, a pipeline of text processing was performed. This pipeline consists of 3 stages: extraction, transformation, and validation. In first stage, a custom Python program was created to extract Thai words from each PDF file utilizing pdfplumber package version 0.6.0 and save the words in UTF-8 text format. Visual examination of all extracted files discovered that 32 PDF files were unsuccessfully extracted. The contents of these files were not intellectually legible. The extracted contents of the other 190 PDF files could be further processed to increase quality.

The transformation stage involved dictionary-based spell checking and correction. This study used Thai word tokenizer and Thai dictionary from PyThaiNLP version 3.0.0 package (Phatthiyaphaibun et al., 2022). PyThaiNLP is the de facto Python Thai natural language processing package. Its tokenizer is matured, and its dictionary contains more than 62,000 words. This study applied a combination of heuristic-based and dictionary-based tokenizer because heuristic was well complemented by the comprehensive dictionary. Tokenized words were spell checked against the dictionary. The program in this stage kept the statistics of misspelling words (i.e., heuristic-based) across the 190 files and listed top-100 most frequent misspelled words. This list showed two types of misspellings. First type, the most common, words were genuinely misspelled by the PDF extraction process. The Thai language encoding complexity in PDF was beyond pdfplumber capability. To aid this type, a targeted spelling correction routine was crafted using the knowledge from the top-100 misspelled words. Second type, the tokenizer incorrectly separated words because these words were n-grams. There were possibilities of having unusual sets of words (i.e., n-grams) beyond the dictionary (e.g., firm name, and product name). N-grams routine was created to discover the unusual sets across the 190 extracted contents. The routine was instructed to list top-100 most common n-grams from the content. Intellectually legible n-grams were selected and used to extend the existing dictionary.

Transformation stage was iterative. Spelling correction and n-grams enhanced dictionary were iterated according to criteria set forth in the validation stage. This study realized that the efforts to get the last incorrect word would out weight the benefits. This study set a goal to have less than 1% misspelling words in the contents across the 190 UTF-8 text files. This number of misspellings does not jeopardize the validity and reliability of this study due to the reasons presented during similarity calculation. Ultimately, there were more than 300 targeted spelling corrections, and 197 n-grams were included into the dictionary.

Content categorization and annotation

The data preparation yielded 256 source files of freely accessible text contents (i.e., 66 MS-Word files and 190 PDF extracted UTF-8 text files). The content in each file was to be categorized according to the five dimensions covered in the theoretical development and each category was annotated with extensible markup language (XML). The procedure consisted of two steps.

The first step was content categorization. To fully understand this step, one had to understand the content arrangement of the annual report. This study adopted the most recent standard of annual report specified by The Securities and Exchange Commission of Thailand. The specification is 56-1 and has two revisions. Both revisions are compatible with some differences

in subtopics arrangement. The report is divided into 3 sections and each section covers certain area of the business. The areas are operations, management, and financial respectively. Each area is specified to cover several main topics. One main topic includes many subtopics. These subtopics are the primary concern of this study. Quick semantic examination of subtopics across several reports revealed that there were several ways in phrasing a shared meaning of subtopics in Thai language. Direct mapping could not be carried out because the variation is numerous. Therefore, each subtopic was read and assessed its meaning by human. If its meaning agreed with one of the five organizational dimensions, discussed in the previous session, its content was consequentially classified as data of the dimension. This study established meaning of each dimension consistence with the literature. The mission statement was the direct capture from content of the annual report. There was no meaning assignment. The meaning of organizational operation dimension covered operational strategy, operational management, operational policies, operational improvements, and operational partners and partnerships. The meaning of competition dimension included industry competition, peer competition, competitive advantages, and competition opportunities. The meaning of products and services dimension encompassed various topics about innovation, categories, research and development, challenges, and production of the products and services. The last dimension, risk, addressed the topics about risk analysis, risk mitigation, risk management, organization constraints, and perceived threads.

The second step annotated the categorized content with the XML. An XML file with report attributes (i.e., stock exchange TICKER and year of the report) and the five dimensions was prepared for each annual report. The categorized content in the first step was copied from the source file to the XML file. This 2-steps procedure was manually carried out for each source file by the researcher and his assistance. The result was annotated contents in 256 XML files, matching the 66 MS-Word and the 190 PDF extracted UTF-8 source files. Fig 1 displays an example of the XML file.

Before	After
<code><report format=56.1 ticker=HANA year=2563></code>	<code><report format=56.1 ticker=HANA year=2563></code>
<code><mission></code>	<code><mission></code>
	เพื่อทำธุรกรรม ...
<code></mission></code>	<code></mission></code>
<code><operation></code>	<code><operation></code>
	ให้บริการธุรกรรม ...
<code></operation></code>	<code></operation></code>
<code><competition></code>	<code><competition></code>
	การให้บริการ ...
<code></competition></code>	<code></competition></code>
<code><product></code>	<code><product></code>
	1. บริการ ...
<code></product></code>	<code></product></code>
<code><risk></code>	<code><risk></code>
	ความเสี่ยง ...
<code></risk></code>	<code></risk></code>
<code></report></code>	<code></report></code>

Fig 1. XML example of before and after classification and annotation of a report

Similarity calculation

The objective at this stage is to perform cross-dimensions similarity calculation in each XML file. Before proceeding with the calculation, a python program scanned annotated contents in the 256 XML files to assess completeness of the text data. The program discovered files with empty dimensions. Some reports did not have contents covering all the planned dimensions. This study dropped XML files with any empty dimension because the empty dimension did not aid the calculation. However, empty dimensions must not be regarded as missing data because this emptiness is valid, but missing data is invalid. The program listed that 215 XML files (i.e., annotated annual report) readied for similarity calculation.

This study implemented 3 steps to achieve similarity calculation. The first step created pairs of contents from each dimension. There were 5 dimensions with their contents in each XML file. Therefore, there were 10 possible dimension-pairs of contents. The pairs were mission-operation (MISN-OPER), mission-competition (MISN-COMP), mission-product (MISN-PROD), mission-risk (MISN-RISK), operation-competition (OPER-COMP), operation-product (OPER-PROD), operation-risk (OPER-RISK), competition-product (COMP-PROD), competition-risk (COMP-RISK), and product-risk (PROD-RISK).

The second step, contents of each pair were vectorized using TF-IDF (Robertson, 2004). This vectorizer helped elevate differences between contents of the dimension-pair. Sklearn package version 0.24.1 provided the TF-IDF vectorizer. Content of each dimension was separated into words by the heuristic-based and dictionary-based tokenizers used during the data preparation. Each word was kept in one instance to equalize representation in the content. The heuristic-based words presented no concern because their tokens were similar across dimensions in the XML file. Vectorizer paid no difference between heuristic-based and dictionary-based tokens. This second step resulted in 10 TF-IDF vector-pairs corresponding to the 10 dimension-pairs in each XML file.

Cosine similarity measure (Tata & Patel, 2007) was used to calculate contents' similarity in the third step. Function for the measure was provided by Sklearn package version 0.24.1. Each TF-IDF vector-pair was entered into the similarity function and output from the function was one value. When this value is closer to 0, the vector-pair is very different. On the other hand, the vector-pair is very similar when the measure is closer to 1. Each XML file contained 10 dimension-pairs. As result, there were 10 cosine measures for each file. Two-hundred fifteen XML files from 215 annual reports were sent to the measure

function. Hence, the output matrix was 215 rows and 10 columns. The 215 rows were for the 215 annual reports and 10 columns were for the 10 cosine similar measures across the 10 dimension-pair. This matrix contains data for the discovery of organizational congruence.

RESULT

Exploratory factor analysis (EFA)

This study utilized exploratory factor analysis to discover latent dimensions of organizational congruence. Before carried out the analysis, basic characteristics of the data matrix were examined. Table 1 displays these characteristics. There was nothing out of the ordinary.

Table 1: Correlations of similarity-pairs and descriptive statistics (N=215)

	1	2	3	4	5	6	7	8	9	10
MISN-OPER	-									
MISN-COMP	0.718*	-								
MISN-PROD	0.732*	0.892*	-							
MISN-RISK	0.710*	0.873*	0.881*	-						
OPER-COMP	0.042*	0.009*	0.038*	0.038*	-					
OPER-PROD	0.034*	-0.045*	0.090*	0.040*	0.852*	-				
OPER-RISK	0.136*	0.085*	0.139*	0.199*	0.792*	0.761*	-			
COMP-PROD	-0.221*	-0.032*	0.041*	-0.060*	0.616*	0.606*	0.418*	-		
COMP-RISK	-0.167*	0.030*	0.059*	0.051*	0.456*	0.351*	0.510*	0.732*	-	
PROD-RISK	-0.127*	-0.017*	0.128*	0.080*	0.466*	0.568*	0.634*	0.704*	0.801*	-
Mean	0.252	0.256	0.235	0.234	0.514	0.523	0.486	0.570	0.545	0.529
S.D.	0.108	0.093	0.078	0.079	0.107	0.123	0.098	0.110	0.088	0.105
Min	0.055	0.051	0.039	0.032	0.216	0.228	0.201	0.320	0.318	0.258
Max	0.606	0.457	0.442	0.721	0.782	0.680	0.775	0.758	0.752	0.606

* P < 0.05

The EFA calculation utilized routine FactorAnalyzer in python package factor_analyzer version 0.4.0. To ensure the data's suitability for factor analysis, Bartlett's test of sphericity and Kaiser-Meyer-Olkin (KMO) were carried out (Lewis et al. 2005). The Bartlett's chi-square is 2303.38 with p-value less than 0.01 and KMO value was 0.71. These results confirm suitability of the data.

The factor analysis was calculated in two phases. The first phase was to determine the appropriate number of factors. There was no rotation during this phase. The eigenvalues of the first 10 factors were the following: 4.132, 3.418, 1.090, 0.480, 0.303, 0.272, 0.107, 0.079, 0.062, and 0.055. Nunnally (1978) recommends component with eigenvalue more than 1.

The second phase modeled the top-three components with varimax rotation. The statistical results of the model are in table 2. This model accounts for 81% of overall variance. All components have Cronbach's alpha ranging from 0.89 to 0.93. These values are higher than the recommended cutoff criteria at 0.7 and indicate good reliability of the three components. The variable loadings of each component are high with low cross-loadings. These loadings indicate good convergent and divergent validity. Therefore, all the statistical information suggests satisfactory validity and reliability of the model.

Table 2: EFA results

	Construct-1	Construct-2	Construct-3
MISN-OPER	0.785	0.112	-0.233
MISN-COMP	0.935	-0.042	0.032
MISN-PROD	0.947	0.030	0.096
MISN-RISK	0.928	0.036	0.045
OPER-COMP	0.005	0.888	0.272
OPER-PROD	0.002	0.900	0.253
OPER-RISK	0.135	0.759	0.344
COMP-PROD	-0.083	0.414	0.701
COMP-RISK	-0.000	0.205	0.912
PROD-RISK	0.019	0.378	0.796
Individual variance	0.327	0.255	0.228
Cumulative variance	0.327	0.582	0.810
Cronbach's alpha	0.931	0.920	0.892

The construct-1 loadings are firmly supported by variables connected to organization's mission. Environmental scanning and anticipation of future establish mission statement (Morris, 1987). This statement gives organization's purposes and goals. It represents the organization's reason for existing. Congruence perspective scholar maintains that firm's functions and resources must be aligned with the mission to achieve superior performance (Sillince, 2005). The variables' loadings clearly demonstrate

the alignment. Furthermore, this alignment is closely parallel to the concept of strategic consensus. Porck et al. (2020) defines strategic consensus as shared strategic understanding and strategic priority across organization. It is a type of organization internal congruence. Humburg et al. (1999) proposed two dimensions of strategic consensus. First dimension is subject of consensus. This dimension is revealed by the variable-pairs. The subjects are operation, competition, product, and risk. These subjects are consensus on the mission. Second dimension is object of consensus. In the context of this study, the objects are unique words in narrative of each subject that brought the subject closer to the narrative of the organization's mission. Both dimensions of strategic consensus are satisfied. This satisfaction strongly suggests that the construct-1 is the strategic consensus.

The construct-2 is manifested by the close-associations of variables based on the organization's operation. The narrative of competition, product, and risk contained very similar unique words to that of operation. Literature recognizes this formation of close-associations as operational congruence (aka, operational consistency, and operational alignment). This congruence materializes because of the complementary gains of the co-alignment between operational routine and the three other areas. The first, a comprehensive and systematic reviewed by Sansone et al. (2017) informed that six competitive dimensions were enhanced: cost, quality, delivery, flexibility, service, innovation, and environment. The reasons for this enhancement were better operations capabilities and improved competitive prioritization. Second area, product's scale and scope expansions require organization's operational congruence (Brahm et al., 2021). Organizations commonly tradeoff between product's scale and scope expansions because of resources' constraint. Brahm et al. (2021) discovered that both expansions are not mutually exclusive when operational congruence is in effect. Third area concerns operational risk. Organization's risks can be classified to either external or internal. Operational risks are largely internal stemming from activities related to resources and humans (Wang et al. 2020). This type of risks is mostly in routine and preventable in advance by monitoring and risk mitigation (Kaplan & Mikes, 2012). When risky incident arrives, the organization must have capabilities to mitigate uncertainty. One such capability is the ability to adapt. Congruence is a fundamental driver for adaptation because it demands organization to minimize difference between uncertainty brought about by the incident and current operation (Sarta et al., 2021). Literatures across the three areas inform that the second construct is the operational congruence.

Three variables strongly loaded on the third construct. This is a manifestation of competitive congruence. The risk related variables are the opposite to that of the second construct. The variables focus on external risk. This type of risk is originated from competitive environment (Shepherd, 1999). In agreement with the variables, the environment posts organization with two sources of risks. First is from competition among competitors. This source concerns threats materialized from competitors' activities (Gómez et al., 2020). Second source is from competition among products. Competing products lead to substitution and switching. Both are threats to organization's competitive position. When risk from competitive environment presents itself, organization's investment becomes liability and return on investment is uncertain. The organization is mindful of the risk. Therefore, there is congruence among competition, product, and risk. Last variable (i.e., COMP-PROD) expresses close relationship between competition and product. This relationship is to be expected because it accelerates product innovation, particularly in the IT industry (Chen et al. 2021). Competition encourages research and development investment and knowledge collaboration within the competitive community. Thus, the third construct is conceptually equivalent to competitive congruence.

Confirmatory factor analysis (CFA)

The latent constructs were unveiled, and these constructs needed further refinement. Confirmatory factor analysis (CFA) was conducted using the maximum likelihood estimation to validate the constructs. AMOS 28 carried out the CFA estimations. Table 3 displays the results. Model 1 was the direct model from EFA. Its fit indices (i.e., CFI, GFI, NFI, TLI, RMSEA) suggested lower than satisfactory fit (Cheung & Rensvold, 2002). One notable coefficient was the correlation between operational congruence and competitive congruence at 0.640, P-value < 0.05. This statistical significance indicated potential second-order latent construct. Therefore, model 2 was specified by the guide of this significance. The second model did not show any improvement over the late model. There was no change in Chi-square and fit indices. However, it unveiled correlation structure among the error variances via the modification indicators. This structure gave rise to the model 3.

Table 3: CFA models

	Model 1	Model 2	Model 3
	Coefficient	Coefficient	Coefficient
Strategic consensus (1 st order)			
MISN-OPER	0.767	0.767	0.767
MISN-COMP	0.939	0.939	0.937
MISN-PROD	0.950	0.950	0.954
MISN-RISK	0.928	0.928	0.926
AVE	0.808	0.808	0.808
CR	0.944	0.944	0.944
Operational congruence (1 st order)			
OPER-COMP	0.933	0.933	0.930
OPER-PROD	0.907	0.907	0.893
OPER-RISK	0.851	0.851	0.867

AVE	0.806	0.806	0.805
CR	0.926	0.926	0.925
Competitive congruence (1 st order)			
COMP-PROD	0.823	0.823	0.844
COMP-RISK	0.881	0.881	0.907
PROD-RISK	0.892	0.892	0.858
AVE	0.750	0.750	0.757
CR	0.900	0.900	0.903
Ambidexterity (2 nd order)			
Operational congruence		1.082	0.932
Competitive congruence		0.591	0.844
AVE		0.760	0.790
CR		0.854	0.883
Correlations			
Strategic cons. ↔ Operational cong.	0.062		
Strategic cons. ↔ Competitive cong.	0.034		
Operational cong. ↔ Competitive cong.	0.640		
Strategic cons. ↔ Ambidexterity		0.057	0.061
$e(\text{OPER-RISK}) \leftrightarrow e(\text{COMP-PROD})$			-0.679
$e(\text{OPER-PROD}) \leftrightarrow e(\text{COMP-RISK})$			-0.569
$e(\text{OPER-COMP}) \leftrightarrow e(\text{PROD-RISK})$			-0.792
$e(\text{OPER CONG.}) \leftrightarrow e(\text{COMP-RISK})$			-1.186
$e(\text{COMP CONG.}) \leftrightarrow e(\text{MISN-OPER})$			-0.697
Fitness statistics			
CFI	0.810	0.810	0.959
GFI	0.728	0.728	0.911
NFI	0.800	0.800	0.948
TLI	0.733	0.733	0.931
RMSEA	0.252	0.252	0.128
ΔX^2			$df=5, 345.321$

The fit indices of model 3 indicated satisfactory fit (Cheung & Rensvold, 2002) and were markedly improved over model 1 and model 2 judging by the chi-square difference ($p < 0.05$). The model was checked for construct internal reliability, divergent validity, and discriminant validity. All average variance extracted (AVE) and composite reliability (CR) values were higher than the suggested cutoff 0.5 and 0.7 respectively (Hair et al., 2010). Internal reliabilities of all constructs are indicated. All variables statistical significantly ($p < 0.05$) loaded on their respective latent constructs with values ranged between 0.767 and 0.932, larger than recommended 0.6 cutoff values (Hair et al., 2010). Constructs' convergent validity is confirmed. Discriminant validity was checked by the reported correlation between construct and the square root of the AVE values of each construct. The correlation was not significant ($p > 0.05$) and the square root values were more than correlation between the constructs. This suggests discriminant validity. Lastly, the statistical evidence thus far satisfies the criteria for second-order model (Johnson et al., 2011)

The emergence of model 3 revealed insights into the second-order construct. The loading values of its first-order constructs suggest that this construct contains 2 sub-constructs, and these sub-constructs have positive relationships with the second-order construct. Literature suggests that these relationships are akin to the concept of ambidexterity. Tushman & O'Reilly (1996) observed that organization survival required coevolution with its environment through two mechanisms of changes. One is evolutionary and another is revolutionary. A primary task of management team is to balance these two mechanisms. The researchers called for ambidextrous organization. He & Wong (2004) illuminated the nature both mechanisms through the lens of exploitation (i.e., evolution) and exploration (i.e., revolution) within the context of technological innovation. They discovered that both exploitation and exploration were loosely coupling and had combined positive effects on organization performance. Both mechanisms enhance organization performance through different means. Exploration helped performance through adaptation and experimentation, while exploitation increased efficiency and effectiveness through internal alignment (Gibson & Birkinshaw, 2004).

Exploration primarily situates within competitive congruence. It has been mentioned in literature using the words like "flexibility, experimentation, variation, discovery, innovation, creation, pioneer, and research" (Moss et al., 2014, p. 60). The spirit of these words is forward looking and future oriented. This spirit is well aligned with activities that entrench competitive position (Chen et al., 2022). Exploitation largely centers on operational congruence. Moss et al. (2014) pointed out that exploitation is commonly implemented in the guise of automation, routinization, and refinement. These implementations are most effective with alignments of operational processes and resources because they help organization continuously gain on economic value. Therefore, the discussion justifies the emergence of ambidexterity as the second-order construct.

DISCUSSION

Conclusion and contribution

This study collected 288 annual reports between 2013 and 2020 of IT-oriented organizations in stock exchange of Thailand. These reports were preprocessed with text extraction, quality assurance, and information annotation processes. This preprocessing resulted in the annotated content of two hundred fifteen reports readied for organizational congruence discovery. The discovery process proceeded with the cosine similarity calculation among the 10 dimension-pairs in each annotated content and produced the matrix of 215 by 10 dimensions. This matrix was entered into exploratory factor analysis. Latent-construct interpretations were attempted. Then, the statistical results of the late factor analysis were used to guide confirmatory factor analysis for final identification. The final CFA model revealed three first-level constructs and one second-level construct. Strategy consensus, operational congruence, and competitive congruence are the first-level constructs. The second-level construct is organizational ambidexterity.

This study makes two major contributions. First, it empirically identifies four organizational level congruences from close inter-relationships among the five dimensions. This identification is closely aligned with the heart of congruence perspective because the study did not resource to contingency theorization. Second, it combines CATA with traditional measurement development methodology. This combination enables large data volume processing, cost savings from traditional data collection, and maintain rigor of the results.

Implications

The implication of this study first involves congruence measure method improvements. This study joins a group of quantitative congruent measures (e.g., Lin, 2014; Chatterjee et al., 2021) and provides an alternative to survey-based instrument. The combination of CATA and traditional measure modeling process provides both convenience and fidelity. Previous congruence studies measured their congruence-related constructs using survey-based instrument. Implementation of this type of instrument is costly, time consuming, and prone to subjective errors. Furthermore, it involves other parties such as ethic-committee and distribution channels, which amplify data collection uncertainty. The key advantage of the proposed method is that large volume of data can be collected from reliable sources and shaped into high quality contents for the study. The volume and quality help heighten the study's fidelity.

The second implication involves the application of congruence-based constructs. Congruence perspective may prove to be more valuable than contingency in forthcoming environment. Khanagha et al. (2018) suggests that incongruence detection is becoming more important than achieving all-around congruence in technological disruptive environment. The quick detection enables organization to initiate adaptation, which ranges from strategy to resource adjustments. Traditional measure method may not be as effective as the proposed method.

The third implication involves general progress of congruence for organization perspective. The perspective has been the foundation for other perspectives such as contingency, organizational design, and innovation. However, the perspective itself has recently been a slow progress. On the contrary, this study argues that the discovered constructs reaffirm the relevant of the perspective in contemporary literature. For example, strategic consensus is explored within the context of internal congruence (Lewis & Clark, 2020). In addition, ambidexterity is very much involved in organizational innovation (Maclean et al., 2021).

Limitation and future direction

This study recognizes several limitations, but also many future opportunities. First, it did not pursue causal relationships between the organizational congruences and other constructs. Provided, the result satisfies the aim of this study. The tradition of measure development may suggest that this satisfactory is not fully compliance with the preferred procedure. Nomological validity or the effectiveness evaluation of the measured construct should be carried out by examining causal relationships with other constructs under the theoretical scope (Salisbury et al., 2002). This study acknowledges the absence and takes this absence as the opportunity for future improvement. Second, CATA may pose threats to the result's reliability. The result of this study centers on the similarity score. Cosine similarity is not the only text similarity score. Jaccard similarity is another popular alternative. Nonetheless, both cosine similarity and Jaccard similarity have demonstrated convergence under CATA studies (Arts et al., 2018). Additionally, McKenny et al. (2018) pointed out that CATA is prone to specific factor error by the preselection of words. This study attempted to mitigate the error by incorporating hand-coded categorization. However, this mitigation may lead to transient error that similarly phased topics in different reports contained different semantic of contents. One topic contained a quite departed narrative from another similarly phased topic when both topics should tell quite similar narratives. This is an opportunity for improvement. Recent advances in word embedding analysis can help assess the semantic differences (Zhu et al. 2022). This study takes this as a future direction. Lastly, this study was conducted using data from one country. Its generalizability is quite limited. Cross country examination is another potential direction.

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Would you mind your language, please? Consumer incivility on social media platforms

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ABSTRACT

Consumer incivility on social media platforms has recently gained the attention of academic researchers. However, few studies have presented the role that consumer incivility plays in forming social media perspectives (e.g. experiencing uncivil comments or rude replies on Facebook, Twitter and Instagram). Using the stimulus-organism-response theory, this study investigated the impacts of consumer incivility on social media brand representatives' efforts to deal with it, social media brand community participation and social media brand trust. The study also investigated the influence of social media brand representatives' efforts to deal with consumer incivility on social media brand community participation and examined the relationships of these two factors with social media brand trust. Two hundred and forty social media consumers who had witnessed the effect of consumer incivility on social media community platforms completed the study questionnaires. SPSS 23 and SmartPLS-SEM (v. 3.3.7) were used to analyse the data obtained and to test the hypotheses. The results revealed that consumer incivility was significantly inversely associated with the causal constructs. The present study provided novel insights for high-tech social media industries, including digital marketers and community developers.

Keywords: Consumer incivility, social media brand community participation, social media brand representatives' efforts, social media brand trust.

INTRODUCTION

Should social media brands (e.g. Facebook, Twitter, Instagram) control consumer incivility on their social media platforms? A large majority of Americans and other Westerners view consumer incivility as a problem and believe that social media must be blamed for it. This finding is supported by many other surveys (e.g. Bacile *et al.*, 2018; Shandwick, 2019) that documented a perception of rising consumer incivility because many consumers had experienced incivility on social media platforms. Thus, social media is considered the root of incivility. Sometimes, consumer incivility takes place on a brand's social media page, which means that social media brands are faced with a new question: Should they police the rising incivility taking place on their brand's social media pages? While social media brand communities foster global connectivity, they also foster cyber-conflict cases. To illustrate, around 7.9 million hate words were deleted from Facebook in the first quarter of 2021. Consequently, 36% of US adults have minimised their social media use due to their experiences of online harassment (Johnson, 2021).

Recent studies (e.g. Algharabat *et al.*, 2020; Wolter *et al.*, 2022; Heinonen, 2017; Hollebeek & Chen, 2014; Obeidat *et al.*, 2020) have examined positive valence antecedents (including social, relational, hedonic and cognitive) of consumer engagement and participation. However, few studies have focused on the dark side of social media marketing (Dwivedi *et al.*, 2021), and whether consumer incivility influences consumer engagement and participation is unknown (Wolter *et al.*, 2022). Because of uncivil consumer responses on social media forums, the question remains: How does customer incivility (i.e. reading aggressive or uncivil comments on social media platforms) affect social media brand trust and social media brand community participation?

We used the stimulus-organism-response (S-O-R) model to understand consumer incivility by framing stimuli (S) that affect an organism's internal state (O), causing the organism to respond to the environment (R) on a social media platform. Therefore, the present study mainly focused on consumer incivility in the social media setting, which disrupts the service experiences of consumers who have witnessed the uncivil acts. Obeidat *et al.* (2018) conducted a study on such behaviours (e.g. extended consumer complaining, vindictive word of mouth). Therefore, we investigated the inverse impacts of consumer incivility on social media brand representatives' efforts to deal with it, social media brand community participation and social media brand trust. Thus, the study sought answers to the following research questions:

RQ1: Does consumer incivility inversely influence social media brand community participation, social media brand representatives' efforts to deal with consumer incivility and social media brand trust?

RQ.2 How do social media brand representatives' efforts to deal with consumer incivility affect social media brand community participation in social media platforms?

This study has two main contributions. Firstly, it provided new theoretical insights about the backgrounds and levels of trust of the members of social media brand communities in the social media brands. This was the first study to empirically scrutinise the impacts of consumer incivility on social media brand community participation, social media representatives' efforts to deal with consumer incivility and social media brand trust (e.g. Facebook, Twitter, Instagram). Secondly, by exploring uncivil consumer behaviours that affect social media brand trust, we were able to propose ways to convey more targeted messages to social media leaders, web designers and members of social media brand communities to encourage them to participate on social media platforms in a variety of social contexts.

The rest of this article proceeds as follows. The relevant literature is reviewed, and the research model that was used, the hypothesis development and the research methods are discussed. Finally, the study results, their implications for theory and practice, the study limitations and directions for future research are presented.

LITERATURE REVIEW

Stimulus-Organism-Response Theory

We used the S-O-R theory in the present study, which helps in understanding consumer behaviour (Mehrabian & Russell, 1974) through the following holistic elements: stimulus, organism and response. We investigated how stimuli (S) affect an organism's internal state (O), causing the organism to respond to the environment (R) on a social media platform. Tombs and McColl-Kennedy (2003) stated that stimuli in an environment help motivate individuals for frontline encounters and consist of 'contextual, physical and social elements' (p. 448). Singh *et al.* (2017) define encounters as 'the interactions and interfaces at the point of contact between an organization and its consumers that promote, facilitate or enable value creation and exchange' (p. 4). Social media environments are the events/episodes where positive or negative social media encounters occur within individual versus group settings. Organism (e.g. social media brand community participation) refers to transitional and progressive states of an individual's emotional and cognitive bonds associated with the stimulus and the response. Finally, social media brand trust is the response and thus the outcome or action of a social media participant.

RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

The research model shown in Figure 1 shows how consumer incivility may affect social media brand representatives' efforts to deal with it, social media brand community participation and social media brand trust. Previous studies on the social aspects of environmental cues in an offline setting have examined consumer-to-consumer and consumer-to-employee interactions. To the best of our knowledge, the research model contributes to the literature exploring how consumers' uncivil behaviours can act as triggers (stimuli) of social media brand community participation (organism) and social media brand trust (response). Thus, we propose the following research model:

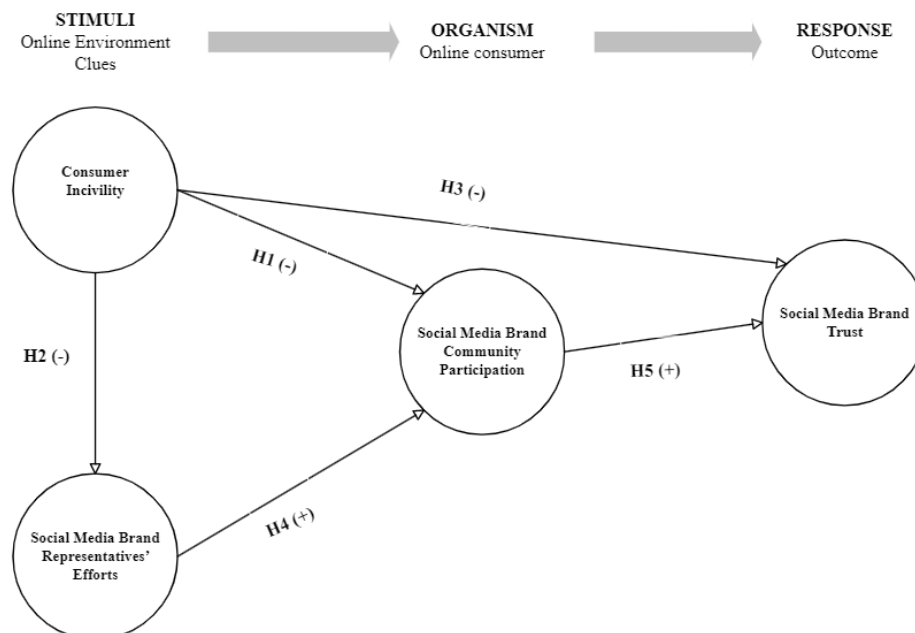


Figure 1: Research Model

Consumer incivility and Social-media brand community participation

Consumer incivility in information system sciences shows that consumers' uncivil acts violate the sociocultural norms in social media (Maher, 2016). Thus, the notion pertains to consumers who are members of a social media brand community expressing hate and hostility (Wolter *et al.*, 2022; Moor *et al.*, 2010). Such uncivil acts can reduce social media brand community

participation that may increase community members' mental distress, social isolation, hostility, frustration and anger (Ransbotham *et al.*, 2016), and at an extreme level, may result in suicide, which has been reported in high school (Bauman *et al.*, 2013). Consequently, we conclude from the literature that uncivil consumer acts are negatively related to consumer brand community participation. Thus, we propose the following hypothesis:

H1: Consumer incivility inversely influences consumer participation in social media platforms.

Consumer incivility, social media brand representatives' efforts and social media brand trust

Social media brand representatives' efforts to deal with consumer incivility are affected by consumer incivility on social media platforms. Sweiss *et al.* (2021) found that the higher the level of efforts of a company's social media brand representatives to deal with consumer incivility, the lower the effect of uncivil consumer acts on the overall reactions of the consumers who are members of the company's social media brand community. In contrast, the lower the efforts of a company's social media brand representatives to deal with consumer misconduct, the higher the impact of such consumer misconduct on social media brand trust and evaluation. For instance, uncivil consumer behaviour negatively and significantly affects consumer evaluation and satisfaction (Huang, 2008), and the influence of consumer incivility is mediated by job satisfaction and professional identity (Huang *et al.*, 2022; Pu *et al.*, 2022). Simultaneously, Huang (2010) reported that uncivil consumer acts influence other consumers' negative word-of-mouth communication and repurchase intentions. Thus, this paper presents the likely consumer evaluation (e.g. social media brand trust) of social media brand communities influenced by consumer incivility and shows how the efforts of the company's representatives to deal with the resulting critical situation can address it. It was hypothesised that the higher the social media representatives' efforts to deal with the situation stemming from customer incivility, the lower the impact of the consumer incivility and the higher the participant trust in the social media brand, and vice versa. Therefore, we propose the following hypothesis:

H2: Consumer incivility inversely influences social media brand representatives' efforts to contain its impact.

H3: Consumer incivility inversely influences social media brand trust.

Social media brand representatives' efforts and social media brand community participation

Social media representatives' efforts pertain to the degree of efforts of the company employees to win the trust of social media brand consumers and to contain the effects of a situation potentially detrimental to the company, such as consumer incivility during community interaction (Huang, 2010). In the social media context, how social media brand representatives' efforts to handle consumer incivility or misbehaviour (Sweiss *et al.*, 2021) regarding complaints and repurchases (De Matos *et al.*, 2009) influence customer loyalty (Karatepe, 2006) and satisfaction (Huang, 2008; 2010) has been seen. The moderating effect of company representatives' efforts to deal with consumer incivility on the relationship between attitude and brand community engagement has also been examined, and significant positive results have been obtained (Obeidat *et al.*, 2020). The present study sought to determine whether the direct effect of social media brand representatives' efforts to deal with consumer incivility on social media brand community participation still has to be established. To fill this research gap, we proposed the following hypothesis:

H4: Social media brand representatives' efforts to deal with customer incivility positively influence social media brand community participation.

Social media brand community participation and social media brand trust

Social media community platforms are technology-driven societies. Social media forums can act as antecedents or mediators of community participation (Hook *et al.*, 2018). From a social media perspective, Kim and Ahmad (2013) define social media brand trust as 'a subject's degree of belief in a content provider's task competence, based on the expectation that the content provider generally and consistently delivers satisfactory and high-quality content in [its] social-media pages [that] consumers are willing to take [the] consumer-generated content provided by the content provider even with the possibility of risk' (p. 440). They add that '[t]his action is accompanied by feelings of security and strong positive emotions' (p. 440). Regarding trust perception, Casalo *et al.* (2008) identified the trust impact on brand communities to establish a community's trust and its members in the community. A few studies have proposed investigating social media brand trust prior to participation (Chen & Ku, 2013; Hur *et al.*, 2011; Tsai *et al.*, 2012). Hook *et al.*'s (2018) proposal to identify how social media brand trust is established after social media brand community participation has yet to be fully implemented. The present study thus analysed how social media brand trust can be gained. Therefore, the following hypothesis was proposed:

H5: Social media brand community participation increases social media brand trust.

METHODS

Data Collection Procedure and Sample

Social media consumers from social media platforms (e.g. Facebook, Twitter, Instagram) were the target sample of the present study, and data were collected through an online Google survey form. The survey respondents were experienced social media consumers from Pakistan and were able to respond to our survey questionnaires related to social media community activities. A hybrid of the convenience and snowball sampling techniques was used because these techniques are the ideal subject recruitment methods in social media settings, such as social media platforms, whose members are identifiable. They

include referrals, making the subject recruitment more time-efficient and making the data easy to access. The non-probability sampling technique is acceptable 'when the purpose of research is theory testing or generalizability' (Calder *et al.*, 1981).

Table 1 shows the social media consumer subjects' gender, education, age, marital status and profession, which were analysed using SPSS 23. Regarding gender, 58% (n = 139) of the subjects were male, and only 42% (n = 101) were female. Regarding education, most were master's degree holders (40%; n = 96), 33% (n = 80) were undergraduate degree holders, 10% (n = 24) were post-graduate degree holders and only 17% (n = 40) were from schools. With regard to age, 30% (n = 72) belonged to the 26–35 age group, 27% (n = 65) were younger than 25 years and 35% (n = 84) belonged to the 36–45 age group. Only 8% (n = 19) were older than 45 years. Regarding marital status, most were unmarried (55%; n = 132). Lastly, with regard to profession, 54% (n = 129) were employees, 23% (n = 56) were businesspeople, 18% (n = 44) were house husbands and 5% (n = 11) were retired.

Table 1: Respondents' Profile

Characteristics	N	%	Characteristics	N	%
Gender:			Age:		
Male	139	57.9	Less than 25	65	27.1
Female	101	42.1	26 to 35	72	30
Total	240	100	36 to 45	84	35
Education:			More than 45	19	7.9
Matriculation	17	7.1	Total	240	100
Intermediate	23	9.6	Profession:		
Under-Graduate	80	33.3	Employee	129	53.8
Masters	96	40	Businessperson	56	23.3
Post-graduate	24	10	Household	44	18.3
Total	240	100	Retired	11	4.6
Marital Status:			Total	240	100
Single	132	55			
Married	108	45			
Total	240	100			

Measurement Instrument

To measure the variables, the present study adopted questionnaire items from previous studies and modified them to make them fit the context of the social media environment. An eight-item scale for social media brand community participation developed by Dessart *et al.* (2016) was adopted. Social media representatives' efforts to deal with consumer incivility were measured using Huang's (2010) four-item scale. To measure social media brand trust, we adapted Chaudhuri and Holbrook's (2001) four-item scale. Jung *et al.*'s (2017) six-item scale for consumer incivility was adopted and modified to fit the context of consumer incivility in the present study (social media). A 5-point Likert scale ranging from 1 ('strongly disagree') to 5 ('strongly agree') was used to respond to the questionnaire items.

RESULTS

We have followed two step-procedure of Structural Equation Modelling with measurement and structural model assessment.

Measurement Model Assessment

Individual Item Reliability

As suggested, item reliability should be assessed through the analysis of the factor loadings (Hair *et al.*, 2014; Hulland, 1999). According to Field (2009), a factor loading below 0.5 is unacceptable. We dropped one item from the consumer incivility (CI6) and two-items from the social media brand community participation (e.g. SMCP5 & SMCP6). Following Field's (2009) recommendation, we retained the items with 0.5 minimum loadings. The item loadings are shown in Table 2.

Internal Consistency Reliability

The composite reliability value was measured to determine the items' internal consistency. According to Hair *et al.* (2011), a threshold value of 0.7 or above is recommended, and we found composite reliability within the 0.807–0.957 range for each variable. The values obtained met the criteria recommended by Bagozzi and Yi (1988), thus establishing the internal consistency of each construct in the model.

Table 2: Measurement model

Construct	Item	Standardised loading
Consumer incivility ($\alpha = 0.783$; CR = 0.894; AVE = 0.539)		
CI1	'The other consumer behaved in a way I do not agree with.'	0.738
CI2	'The other consumer conducted themselves in a manner I do not find	0.727

	appropriate.'	
CI3	'The other consumer behaved in a way I was not expecting.'	0.705
CI4	'Other consumers complain and give the company and its employees a hard time.'	0.701
CI5	'Other consumers complain to be unpleasant with the company's employees and representatives.'	0.698
CI6	'Other consumers complain to make someone from the company pay for its poor service.'	Removed
Social media brand trust ($\alpha = 0.807$; CR = 0.897; AVE = 0.633)		
PT1	'I trust the social media brand.'	0.808
PT2	'I rely on the social media brand community.'	0.803
PT3	'The social media brand has an honest product/service page.'	0.798
PT4	'The social media brand page is safe to use.'	0.772
Social media brand community participation ($\alpha = 0.815$; CR = 0.892; AVE = 0.591)		
SMCP1	'I feel enthusiastic, interested and happy when I interact with the company's social media pages.'	0.658
SMCP2	'I get pleasure from interacting with the company's social media pages.'	0.637
SMCP3	'I share my ideas and interesting content in the company's social media brand pages.'	0.635
SMCP4	'I help other consumers in the company's social media pages.'	0.708
SMCP5	'I ask questions at the company's social media pages.'	Removed
SMCP6	'I seek ideas and information from the company's social media pages.'	Removed
SMCP7	'I promote and defend the company's social media pages.'	0.725
SMCP8	'I say positive things about the company's social media pages to other people.'	0.649
Social media brand representatives' efforts ($\alpha = 0.821$; CR = 0.834; AVE = 0.604)		
SMRE1	'The company's social media brand representatives exert a lot of energy to deal with consumer incivility situations.'	0.821
SMRE2	'The company's social media brand representatives exert much effort to resolve consumer incivility situations.'	0.807

CR = composite reliability; AVE = average variance extracted

Convergent Validity

The convergent validity test evaluates the constructs with average variance extracted (AVE) values (Fornell & Larcker, 1981). The AVE values should be 0.50 or higher (Chin, 1998). Table 2 indicates AVE scores from 0.689 to 0.851, thus establishing adequate convergent validity.

Discriminant Validity

Due to the recent criticisms of Fornell and Larckers' (1981) criterion, we determined the discriminant validity in the present study through the heterotrait-monotrait method. The multitrait-multimethod matrix was followed, where a threshold value of less than 0.85 indicates adequacy (Kline, 2011). We found discriminant validity values within the threshold, indicating that discriminant validity had been established for all the constructs (see Table 3).

Table 3: Discriminant Validity (HTMT Ratio)

Latent Constructs	Consumer Incivility	Social Media Brand Trust	Social Media Brand Community Participation	Social Media Brand Representatives' Efforts
Consumer Incivility	-			
Social Media Brand Trust	.744			
Social Media Brand Community Participation	.669	.831		
Social Media Brand Representatives' Efforts	.396	.378	.354	-

Structural Model

Structural model assessment was used to examine our proposed hypotheses, following Hair *et al.*'s (2014) and Henseler *et al.*'s (2009) recommendations. Table 4 shows the results of the structural model assessment.

R² Assessment

According to Hair *et al.* (2011) and Henseler *et al.* (2009), 0.75, 0.50 and 0.25 R-square values report substantial, moderate and weak levels of accuracy, respectively. The R-square value obtained in this study was 0.338 for social media brand community participation, indicating that the exogenous variables of consumer incivility and social media brand representatives' efforts to deal with consumer incivility combined explained 33.8% of the variance in social media brand community participation. However, the R-square value for social media brand trust was 0.532, indicating that the research model explained 53.2% of the variance in such a variable. The R-square values found in this study are presented in Table 4.

Table 4: Structural Model Assessment

Hypotheses	Relationship	β	T Value	P Value	Decision
H1	Consumer Incivility -> Social Media Brand Community Participation	-0.342	3.217	0.000	Supported
H2	Consumer Incivility -> Social Media Brand Representatives' Efforts	-0.450	7.976	0.000	Supported
H3	Consumer Incivility -> Social Media Brand Trust	-0.543	9.165	0.000	Supported
H4	Social Media Brand Representatives' Efforts -> Social Media Brand Community Participation	0.197	3.703	0.000	Supported
H5	Social Media Brand Community Participation -> Social Media Brand Trust	0.509	8.213	0.000	Supported

R² Adjusted: Social Media Brand Community Participation 33.8%, Social Media Brand Trust 53.2%

Assessment of the effect size of the model

As per Chin (2010), researchers should determine the effect size (f^2), which is complementary to R-square (R^2). Cohen's (1988) f^2 values of 0.02, 0.15 and 0.35 were interpreted as small, medium and large, respectively. Table 5 shows that the effect size for the path from consumer incivility to social media brand community participation (0.237) and consumer incivility to social media brand brand trust (0.152) was moderate as per Cohen's (1988) criteria, whereas the effect size for the path from social media representatives' efforts to deal with consumer incivility to social media brand community participation (0.048) was small. The effect size for the path from social media brand community participation to social media brand trust (0.393) was large.

Table 5: Effect Sizes of Latent Variables

Latent Constructs	Social Media Brand Community Participation	Social Media Brand Trust
Consumer Incivility	0.237	0.152
Social Media Brand Representatives' Efforts	0.048	
Social Media Brand Community Participation		0.393

DISCUSSION AND FUTURE DIRECTIONS

Due to the growth of consumer incivility cases on social media platforms, the present study was motivated to contribute to the literature on the science of consumer incivility in the digital/social media context.

Theoretical Implications

The present study examined an unexplored research topic concerning consumer incivility in the social media context. To contribute to the body of literature, the results of the research hypotheses driven from conceptual models (H1, H2, H3, H4 and H5) are presented herein.

Firstly, the study findings support H1, suggesting that the higher the level of consumer incivility, the lower the level of social media brand community participation. To the best of our knowledge, the present study was the first to explore the impact of consumer incivility on social media brand community participation. Previous researchers have examined constructs/variables that are possible antecedents of consumer participation or engagement in an online context (Algharabat *et al.*, 2020). The findings of the present study show that in the social media context, uncivil consumer behaviour has inverse impacts on social media community participation, social media brand representatives' efforts to deal with consumer incivility (H2) and social media brand trust (H3). Thus, H1, H2 and H3 are supported.

Secondly, the study findings show that social media personnel's efforts to deal with consumer incivility influence social media community participation (H4), and social media community participation develops social media brand trust (H5). Thus, H4 and H5 are supported.

Finally, the present study was extended to the SOR theory, enhancing the influence of consumer incivility and social media brand representatives' efforts to deal with it on social media brand community participation, which produces positive or negative social media brand trust.

Managerial Implications

Content/ service providers should communicate dyadic approaches in terms of focal uncivil consumer-to-consumer and consumer–firm interactions based on interactive practices. For instance, service providers should monitor consumer complaint activity separately from other consumer–firm interactions in social media. These separate social media forums co-create information exchanges between consumers and firms (Skálén *et al.*, 2015). However, Bacile *et al.* (2018) recommended that standard operating procedures (SOPs) be set for complainant consumer handling via social media. It is suggested that firms develop complaint cells to address consumer incivility in accordance with the SOPs. Uncivil consumers affect other consumers and the service providers in the social media environment. Company personnel who are tasked with dealing with uncivil consumers should be trained in business and communication tactics, such as consumer-to-consumer and employee conflict resolution, and in identifying potential uncivil clashes.

Service providers should invest in consumer database software to use consumer relationship management to identify consumer activities on social media. Technological advancements should be employed, such as artificial intelligence algorithms, sentiment analysis and the use of automated software and human talent to monitor consumer–firm interactions on social media channels. This can be a more manageable strategy for dealing with consumer incivility. Firms can trace potentially problematic consumers participating in offensive behaviours on social media platforms. Potential consumer incivility can be assumed to record and capture potentially problematic consumers; these consumers can be engaged and tracked for the purpose of managing uncivil consumers in the modern age of social media activities.

Study Limitations and Directions for Future Research

In today's digital era, consumer acceptance of community participation may result in negative exposure for firms. Thus, it is important to understand consumer behaviour and develop positive engagements using intermediate digital communications (Obeidat *et al.*, 2020). The present study examined the negative impact of consumer incivility on social media brand community participation and social media brand trust and the impact of the company representatives' efforts to deal with it. Based on the study results, it is concluded that social media brand community participation is important for generating social media brand trust, which can be gained by increasing the company representatives' efforts to deal with consumer incivility on social media platforms and to reduce its negative impacts.

This study had some limitations. Firstly, it was limited to developing countries; it could thus be replicated in a developed country context with a large sample. Secondly, the study did not examine the gender (male vs female) differences in community participation in social media forums. Thirdly, the study did not explore the effects of social media brand community participation on consumer intention to engage in consumer incivility for the purpose of minimising consumer incivility intention rather than just dealing with uncivil behaviours when they have already occurred.

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An empirical research on the influencing factors of consumers' intention to use "one-hour e-commerce": Taking JD Daojia as an example

(Work-in-Progress)

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ABSTRACT

The era of "One-hour E-commerce" has arrived, which is of positive significance to meet consumers' needs and enhance their shopping experience. This paper constructs a structural model of the factors influencing consumers' willingness to use "One-hour E-commerce" by using a Technology Acceptance Model with two additional factors: subjective norm and perceived risk. The model was validated through 347 valid questionnaires and analysis. The results showed that perceived usefulness, perceived ease of use and subjective norm positively affects consumers' willingness to use "One-hour E-commerce"; perceived ease of use positively affects consumers' perceived usefulness; perceived risk does not negatively affect consumers' willingness to use "One-hour E-commerce". Based on the above findings, the following recommendations are made: accelerate integration improve the ecosystem; optimize the platform to enhance ease of use; improve delivery to strengthen user satisfaction; improve image to enhance customer service efficiency; focus on quality to improve risk awareness.

Keywords: One-hour E-commerce, Technology Acceptance Model, Perceived risk, Subjective norm, Use intention.

INTRODUCTION

With the fast pace of urban life and the improvement of people's living standards, people's demand for commodity logistics and delivery is getting higher and higher, and increasingly consumers have started to join the "One-hour E-commerce" shopping, so that they can receive goods within one hour. The era of "One-hour E-commerce" has been coming. In this context, it is very necessary to study the factors influencing consumers' willingness to use "One-hour E-commerce", which is of positive significance to meet consumers' needs and improve their shopping experience. According to current studies, there is a lack of research on "One-hour E-commerce", and consumers' willingness to use is the basis of their usage behavior. In the process of "One-hour E-commerce" operation, what factors affect consumers' willingness to use? How should the "One-hour E-commerce" operators improve their service efficiency? In order to discuss and answer these questions, this paper takes "JD Daojia" as the research object. "JD Daojia" has launched the "One Hour E-Commerce" business, which has huge potential for the development of the e-commerce market and is achieving continuous growth in active users. In November 2020, JD united "JD Daojia" launching a super partner program with Walmart, Yonghui, Bubugao, Sam, Seven Fresh, JD Convenience Store and Jianfu. Until November 4, JD had created a one-hour living circle in 328 cities through "JD Daojia", and had reached cooperation with over 570 chain merchants. By the end of first quarter of 2021, "JD Daojia" business had covered more than 1,500 counties and cities nationwide. On January 7, 2022, "JD Daojia" opened One-hour Shopping festival for the Spring Festival. Therefore, it is representative to choose "JD Daojia" as the research object. Based on the Technology Acceptance Model, the theory of planned behavior, and the theory of perceived risk, this paper constructs a hypothetical model of factors influencing consumers' willingness to use "One-hour E-commerce" and verifies the validity of the hypothesis based on the data from the survey questionnaire. The study will provide suggestions to improve the effectiveness of the "One-hour E-commerce" operation service.

THEORETICAL FOUNDATIONS AND RESEARCH MODEL

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a computer model developed by Davis in 1989 that was originally dedicated to explaining computer usage behavior and provides a theoretical basis for explaining the effect of external variables on intrinsic willingness to use. In TAM external variables affect use intention (UI) through perceived usefulness (PU) and perceived ease of use (PEU), and users' actual actions are predicted by intention to use. With the development of information technology, the TAM model has been widely used in the study of users' willingness to use in the fields of online e-learning, e-commerce, and online user behavior. Moreover, the adaptability and reliability of the model have been widely recognized. The "One-hour E-commerce" has brought impact to traditional e-commerce, and the issue of users' willingness to use belongs to the research field of shopping method adoption, thus the research framework of the technology acceptance model can help us explore the

factors affecting users' willingness to use the shopping method of "One-hour E-commerce". Therefore, the following hypotheses are proposed.

- H1: Perceived usefulness (PU) positively affects the willingness to use of "One-hour E-commerce" consumers (UI).
- H2: Perceived ease of use (PEU) positively affects the willingness to use of One-hour E-commerce consumers (UI).
- H3: Perceived ease of use (PEU) positively affects consumers' perceived usefulness (PU).

Theory of Perceived Risk

Perceived risk (PR) was first introduced by Bauer (1960) of Harvard University. According to him, consumers who make a purchase of a good in the market may not get the result they expect before they buy it. Therefore, when a consumer makes a decision to buy, he will not be able to determine the expected outcome of the purchase. Bauer emphasized that consumers' perceived risk is not objective, but their subjective risk, and that perceived risk links the undesirable outcome of buying a good or service with a perception of the possibility of failure. M. Lwin, J. Wirtz and D. Williams (2007) argued that in the electronic or online services domain, security risks are often associated with privacy and system security, which are aspects that users pay close attention to in their usage. A study by A. C. Elkins, N. Dunbar, and B. Adame, et al (2013) found that mobile payment systems with lower perceived risk of use tend to motivate users more. Internet security has become a major factor affecting users' consumption in the Internet economy, and Liang T. X. and Liu S. F. (2022) pointed out that perceived risk has a significant negative impact on intention to use. When consumers use the "One-hour E-commerce" shopping method, they need to provide their cell phone number, email address or other third-party accounts for registration or login, and they have concerns about privacy disclosure and payment security. These concerns fall under the category of perceived risk, and therefore, the following hypotheses are proposed.

- H4: Perceived risk (PR) negatively affects the willingness to use One-hour E-commerce consumers (UI).

Theory of Planned Behavior

The Theory of Planned Behavior (TPB) was first proposed by Ajzen, who found that most people do not act voluntarily but are controlled by certain factors, so Ajzen and Fishbein added a "behavioral control cognition" to the jointly proposed concept of rational behavior (TRA), thus This led to the Theory of Planned Behavior (TPB). The definition of subjective norms (SN) in TPB refers to the influence and pressure from the surrounding people and society that any person must bear when deciding whether to carry out a certain plan or behavior. Y. K. Choi and J W. Totten (2012) found that subjective norms have a significant influence on individual users' technology acceptance and use. Hsu et al. (2006) suggested that subjective norms should include not only interpersonal but also media influences. Zhang R.H. et al. (2022) found that subjective norms directly affect travelers' willingness to use shared cars, and that the social pressure travelers feel about using shared cars includes both group influence and policy system influence. When users use or want to use "One-hour E-commerce" shopping, they are influenced by the opinions of their friends and family about "One-hour E-commerce", especially in the present time when media information is flooding people's lives and users' use of this shopping method is also influenced by media information. These are subjective norms, so the following hypotheses are proposed.

- H5: The subjective norm (SN) positively influences the intention to use of consumers of "One-hour E-commerce" (UI).

Research Model

This research uses the Technology Acceptance Model as the theoretical basis and research framework, and adds two factors, subjective norm and perceived risk, to construct a research model of "One-hour E-commerce" consumers' willingness to use (as shown in Figure1) as well as to research the factors influencing "One-hour E-commerce" users' willingness to use.

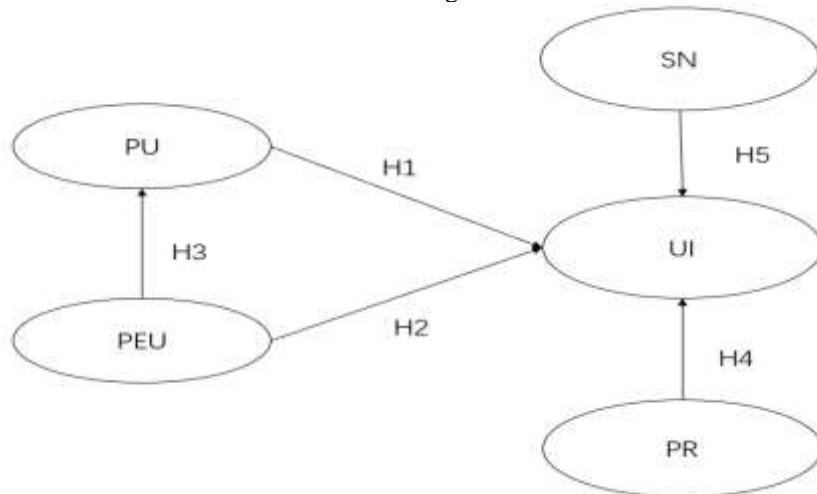


Figure 1 Research Model

RESEARCH DESIGN

Questionnaire design

In this paper, the data is obtained by questionnaire. In order to ensure that the survey results are consistent with the actual situation. The questionnaire was administered to the users of "JD Daojia", the market leader of "One-hour E-commerce". The theoretical basis of the questionnaire was firstly compiled from relevant literature, and the first draft of the questionnaire was designed on the basis of thorough discussions. Then, based on the suggestions from experts and users in related fields, some of the measurement indicators of the questionnaire were modified and improved to form a pre-survey questionnaire. The pre-survey samples were taken from 50 users of different levels of "JD Daojia", and the pre-survey data were analyzed by SPSS, and the questionnaire was modified again through reliability and validity tests to form the official questionnaire. There are 5 variables in the research model, 20 questions in the questionnaire, and the Likert 5-point scale was used to measure.

Data Collection

The questionnaire was conducted in a randomized manner, mainly through online collection and offline distribution of questionnaires, and a total of 400 official questionnaires were distributed. After excluding invalid questionnaires, 347 valid questionnaires were left, with a recovery rate of 86.75%. Among the valid questionnaire respondents, the proportion of men and women are 45.53% and 54.47% respectively; from the age level, it is concentrated between 25-40 years old, most of the consumers in this range have a stable source of income; from the analysis of education, it is obvious that 89.63% of the consumers are concentrated in undergraduate and above, this group of people have a better understanding and acceptance ability for new things. In terms of consumer occupation, 53.6% of the users are white-collar workers and company management who have already started working, and their income is more stable; in terms of disposable family income, 54.75% of the consumers have disposable income of more than 5,000 yuan. After a comprehensive analysis of the above, it is obvious that most of the consumers who currently use the "JD Daojia" platform are young people who have received higher education, have much knowledge, ability and quality to accept new things, and have stable jobs and stable incomes.

DATA ANALYSIS AND RESULTS

Reliability Analysis

The questionnaire of this study was tested for all scales using Cronbach's alpha reliability and the results are shown in Table 1. The SPSS test concluded that: The overall reliability coefficient value of the scale is $\alpha=0.830$, indicating good internal consistency and stability of this questionnaire in general. At the same time, the coefficient of reliability value α of each subscale is greater than 0.8, indicating that each subscale had good stability. The final conclusion is that the reliability of the data reliability of this scale is good.

Table 1 Reliability

Construct	Cronbach α	Items
Perceived usefulness (PU)	.963	4
Perceived ease of use (PEU)	.826	4
Perceived risk (PR)	.854	4
Subjective norm (SN)	.810	4
Use Intention (UI)	.849	4
Total	.830	20

Validity Analysis

The structural validity of the scale was tested by exploratory factor analysis, and the test results are shown in table 2. The KOM value is 0.916, and the Bartlett's sphericity test showed $P=0.000$, indicating that the scale can be subjected to principal component analysis.

Table 2 KMO and Bartlett

KMO and Bartlett		
KMO		.916
	Approx. Chi-square	4691.172
Bartlett	df	190
	P	.000

A total of five principal components with eigen root values greater than 1 were extracted from the scale data through SPSS. The variance explained by these five components were 41.593%, 10.430%, 7.202%, 7.195%, and 5.655%, and the cumulative variance explained was 72.076%.

The results of factor analysis after factor loadings rotation show that the values of commonality (common factor variance) of all factors are higher than 0.6, indicating that there is a strong correlation between the components and factors, and information can be effectively extracted from the analysis. Meanwhile, the values of factor loading coefficients of each load factor

corresponding to this load component are all greater than 0.6, indicating that there is a relative relationship between this factor and this load component, and all factor measures can be fully retained in the analysis of this questionnaire. This also fully demonstrates the relatively good structural validity of the factor analysis of this questionnaire.

The validation factor analysis was used to test the discriminant validity of the scale, and the AVE values for all five factors were greater than 0.5 and the CR values were greater than 0.8, indicating that the data in this study had a good convergent effect. The minimum square root of AVE for each of the five factors was 0.719, which was greater than the maximum value of correlation coefficient of 0.639, indicating that the differential validity of the data used in this study was good.

Correlation Analysis

Correlation analysis was used to analyze the degree of correlation and significance between several different variables. Pearson correlations were performed on the scales and the results are shown in Table 3.

Table 3 Pearson Correlation (Detail)

		PU	PEU	PR	SN	UI
PU	Coefficient	1	.561**	-.383**	.536**	.639**
	P value		.000	.000	.000	.000
PEU	Coefficient	.561**	1	-.315**	.455**	.482**
	P value	.000		.000	.000	.000
PR	Coefficient	-.383**	-.315**	1	-.327**	-.352**
	P value	.000	.000		.000	.000
SN	Coefficient	.536**	.455**	-.327**	1	.498**
	P value	.000	.000	.000		.000
UI	Coefficient	.639**	.482**	-.352**	.498**	1
	P value	0.000	0.000	0.714	0.002	

*P<0.05 **P<0.01

Table3 shows that the correlation coefficient between perceived usefulness and willingness to use is 0.639, $p<0.01$, indicating that there is a positive and significant correlation between perceived usefulness and willingness to use. The correlation coefficient between perceived ease of use and willingness to use is 0.482, $p<0.01$, indicating that there is a positive and significant correlation between perceived ease of use and willingness to use. The correlation coefficient value between perceived risk and intention to use was -0.352, $p>0.05$, indicating that there is a negative but insignificant correlation between perceived risk and willingness to use. The value of the correlation coefficient between subjective norm and willingness to use is 0.498, $p<0.01$, indicating that there is a positive and significant correlation between subjective norm and willingness to use.

Stepwise Regression

Stepwise regression analysis was performed. It is to show the relationship between perceived usefulness, perceived ease of use, perceived risk, subjective norms and use intention. The result is shown in Table4.

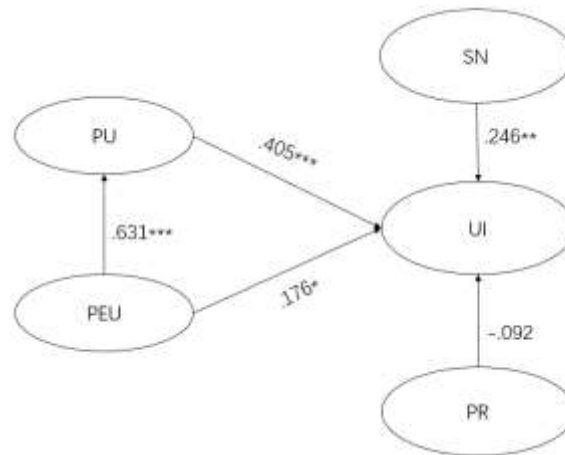
Table 4 Parameter Estimates

UI						
	Ustd. Coe.		Std. Coe.	t	P	VIF
	B	Std. Error	Beta			
Constant	5.954	1.214		4.906	.000	
PU	.396	.048	.439	8.304	.000	1.776
PEU	.136	.052	.129	2.604	.010	1.548
PR	-.079	.040	-.086	-1.961	.051	1.213
SN	.177	.049	.176	3.621	.000	1.500

A specific analysis of the above stepwise regression analysis shows that the regression coefficient of perceived usefulness is 0.396 ($t= 8.304$, $p = 0.000<0.01$), which indicates that perceived usefulness has a positive and significant effect on willingness to use. The regression coefficient value of perceived ease of use is 0.136 ($t=2.604$, $p=0.010<0.01$), indicating that there is a positive and significant effect of perceived ease of use on willingness to use. The regression coefficient value of perceived risk was -0.079 ($t=-1.961$, $p=0.051>0.05$), indicating that perceived risk has a negative but insignificant effect on willingness to use; the regression coefficient value of subjective norm is 0.177 ($t=3.621$, $p=0.000<0.01$), indicating that subjective norm has a positive and significant effect on willingness to use.

Structural Model

The hypotheses testing was conducted by using SPSS, to produce coefficients, statistical significance of the relationship. The significance and the path coefficients present evidences to the nomological validity of the constructs in the conceptual model (As shown in Figure2).



*: $P < 0.05$ **: $P < 0.01$ ***: $P < 0.001$

Figure 2 Structural Model

The research results support the following hypotheses: H1($\beta = 0.405$, $p < 0.001$), H2($\beta = 0.176$, $p < 0.05$), H3($\beta = 0.631$, $p < 0.001$), H5 ($\beta = 0.246$, $p < 0.01$), are supported by the research results. However, H4 is not supported. In other words, Perceived usefulness (PU), Perceived ease of use (PEU) and subjective norm (SN) positively affect the willingness to use of "One-hour E-commerce" consumers (UI). Perceived risk (PR) negatively affects the willingness to use One-hour E-commerce consumers (UI) is not supported.

RESEARCH FINDINGS AND IMPLICATION

Research Findings

- (1) Perceived usefulness positively affects the willingness to use of "One-hour E-commerce" consumers
Consumers will use "One-hour E-commerce" when they get a better experience in using it. In some remote areas, there are too few merchants to conduct "One-hour E-commerce", and consumers can receive too few useful products from it, which will lead to the low willingness of consumers to use "One-hour E-commerce".
- (2) Perceived ease of use positively affects the willingness to use of "One-hour E-commerce" consumers
The easier it is for consumers to understand or use the "One-hour E-commerce", the more likely they are to use it when making purchases. "One-hour E-commerce" is designed to serve consumers better, and when it is too cumbersome to use, consumers will be less interested and less willing to use it.
- (3) Perceived ease of use positively affects the perceived usefulness of "One-hour E-commerce" consumers
Perceived ease of use improves how easy consumers understand or use "One-hour E-commerce"; perceived usefulness is the degree of consumer experience consumers receive. The higher the ease of understanding or use to "One-hour E-commerce", the better the consumer experience. Therefore, when consumers can quickly understand and operate the "One-hour E-commerce", they are more likely to browse and purchase on the "One-hour E-commerce" platform.
- (4) Subjective norms positively affects the willingness to use of "One-hour E-commerce" consumers
Everyone has a herd mentality and is often influenced by their surroundings. This phenomenon is reflected in the "One-hour E-commerce" consumers can be understood as the evaluation of "One-hour E-commerce" by the society and their friends around them will affect the consumers themselves. People subjectively believe that the use of "One-hour E-commerce" will be threatened by risks, so the "One-hour E-commerce" platform should improve its own brand building, increase customer trust in "One-hour E-commerce".
- (5) Perceived risk does not negatively affect the willingness to use of "One-hour E-commerce" consumers
Online consumers like to decide whether to purchase a product by viewing others' reviews of the product. Consumers' perceived risk of "One-hour E-commerce" is initially experienced through other people's evaluation of "One-hour E-commerce". Perhaps the perceived risk of One-hour E-commerce is mostly hidden in the subjective norms, which are reflected to consumers through subjective norms. The lower the perceived risk of One-hour E-commerce, the higher the subjective norm of consumers, and the stronger the willingness of consumers to use "One-hour E-commerce"

Research Implications

Based on the above results and findings, the following strategies are proposed to enhance the willingness of consumers to use "One-hour E-commerce" and to promote the development of the "One-hour E-commerce" market.

- (1) Accelerate the integration and improve its own ecosystem
First of all, the "One-hour E-commerce" platform should accelerate the speed and strength of the integration of online and offline. Seek more local area merchants to join the platform, as far as possible to meet the use of consumers in all areas.

Secondly, "one hour e-commerce" also need to provide high quality products and services, product quality control for merchants, so that consumers can use quality products, improve the consumer's user experience on the platform, enhance customer stickiness.

(2) Optimize the platform to enhance ease of use

First of all, frequently update and maintain the operating system of the "One-hour E-commerce" platform to make the program more smooth. Secondly, the interface design of the software should be simple, clear and easy to understand, so that consumers can use and operate the software quickly and well even if they are first-time users. Finally, the staff of "One Hour E-Commerce" should provide detailed guidance on the operation process to the first-time users of "One Hour E-Commerce", in order to further deepen their understanding of the "One Hour E-Commerce" platform operating system. The staff of "One Hour E-Commerce" should provide detailed instruction on the operation process to further deepen the knowledge and understanding of the operating system of the platform.

(3) Improve distribution and strengthening user satisfaction

The "One-hour E-commerce" model has strict requirements for logistics and distribution services. Therefore, the platform of "One-hour E-commerce" needs to optimize the logistics and distribution procedures, which should make the logistics service: timely order acceptance, fast delivery, and rapid delivery; at the same time, it should also optimize the positioning accuracy in the logistics and distribution process, not only to allow users to check the location of their goods at any time, but also to deliver the products to the exact location within the specified time.

(4) Enhance image and customer service efficiency

"One-hour E-commerce" needs to strengthen its efforts to solve consumers' problems, obtain positive usage reviews, and improve the brand image, which will have a positive effect on consumers' willingness to use it. The "One-hour E-commerce" platform should improve the efficiency of customer service, to ensure that when consumer raises a question, there will be staff to solve his problem in time, so as to improve the consumer experience. In addition, "One-hour E-commerce" also needs to improve the visibility of the platform, such as looking for celebrity endorsement, through the webcast platform to improve the understanding of "One-hour E-commerce" by others.

(5) Focus on quality and improving risk awareness

The "One-hour E-commerce" platform should pay close attention to the quality of goods, and strictly check whether there is a lack of merchants and malicious competition to deliberately discredit other merchants. Raise risk awareness, for all the details that may damage the reputation of the platform should be given attention, through the optimization of the system, the quality of the goods, the merchants strict control, the logistics speed, the user responsibility and other aspects of the joint operation to reduce the user's distrust of "one hour e-commerce", to improve the user's willingness to use.

Research Limits

The hypothesis that "perceived risk negatively affects consumers' willingness to use One-hour E-commerce" was not tested in this research. Through analysis, it was found that the reason may be that this paper only analyzed perceived risk as a single dimension in general. If the perceived risk is broken down into multiple dimensions, the final result may be more standardized and the hypothesis may be proven. In addition, the factors influencing consumers' willingness to use "One-hour E-commerce" are wide-ranging. This paper only takes TAM theory as the basis, and adds two factors, subjective normality and perceived risk, to analyze the corresponding influencing factors. So, in the future study, it needs further exploration of the possible influencing factors based on other theoretical models and analyze the relationship between each influencing factor and willingness to use.

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An empirical study on factors affecting purchase intention of cross-border e-commerce consumer in post-pandemic era

(Work-in-Progress)

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ABSTRACT

The outbreak of COVID-19 promoted the further development of the Cross-border E-commerce (CBEC) industry worldwide. Due to lockdown and home quarantine policies, many countries across the globe followed the complete closure of shopping malls, transport networks, schools, universities, etc. This study aims to investigate factors that influence purchase intention of consumers in CBEC in post-pandemic era. Stimulus-Organism-Response (SOR) model, along with Howard-Sheth Model of consumer behavior and Technology Acceptance Model (TAM) has been employed to develop a structural model for the research. An empirical study including 322 copies of questionnaire were collected and were analyzed by SPSSAU. It has been found that input stimuli such as significant stimuli, symbol stimuli, social stimuli affect personal perception, while personal perception such as perceived risk, perceived usefulness and perceived ease of use affect purchase intention negatively or positively. Based on the study, suggestions were put forward for CBEC platform for further development.

Keywords: Purchase intention, Cross-border E-commerce, SOR, TAM.

INTRODUCTION

Since the broke out of Covid-19, many governments issued home quarantine measures to prevent the spread of the epidemic. In the context of the normalization of epidemic prevention and control, changes in consumer lifestyles have had a more direct impact on the growth of Cross-Border E-Commerce Consumer (CBEC) retail. Deloitte and Touche reports that “overall e-commerce retail sales in major countries in Europe, the US and Asia Pacific experienced high growth of more than 15% between 2019 and 2020” (Pu & Wang, 2021). Online consumer demand continues to release, CBEC has become an important force in stabilizing China's foreign trade. According to the National Bureau of Statistics, in 2021, the national residents' disposable income was 35,100 yuan, an increase of 9.1% year-on-year; per capita consumption expenditure was 24,100 yuan, an increase of 13.6% year-on-year. China's residents' consumption ability is increasing, and the demand for quality imported goods is growing day by day, creating good incremental space for imported CBEC (36Kr Research, 2022).

CBEC Platforms take corresponding measures in the storage, logistics, distribution to respond to the sudden lockdown areas due to the outbreak of epidemics. Hence, consumers also take anti-epidemic measures in the purchasing process, such as information notification, packaging, and delivery of goods, into consideration. This study attempts to investigate factors that influence purchase intention of Chinese consumers in CBEC in post-pandemic era. Based on the Stimulus-Organism-Response (S-O-R) Model, Technology Acceptance Model (TAM) and Howard-Sheth Model of consumer behavior, this study included significant stimuli, symbol stimuli and social stimuli as the input stimuli, observed perceived risk, perceived usefulness and perceived ease of use as the perceptual constructs to investigate the influence on purchase intention.

THEORITICAL BASIS AND HYPOTHESES

The Stimulus-Organism-Response Model

The Stimulus-Organism-Response (S-O-R) Model was proposed by Mehrabian and Russell in 1974. In the classical S-O-R model, *stimulus* is defined as those factors that affect internal states of the individual and can be conceptualized as an influence that stimulates the individual (Eroglu, Machleit & Davis 2001). According to Bagozzi (1991), when consumer behavior is depicted as an S-O-R system, the stimuli are external to the person and consist of both marketing mix variables and other environmental inputs. In this study, the stimuli are the significance, symbol and social stimuli as they affect the perceived sense of the consumer. *Organism* refers to internal processes and structures intervening between stimuli external to the person and the final actions, reactions, or responses emitted (Bagozzi, 1991). Organism represents the internal emotion and psychological process after encountering the stimulus and here in the study organism refers to the perceived risk, perceived usefulness and Perceived ease of use. *Response* in the model refers to the final behavioural outcome of an individual that may be positive or negative (Donovan and Rossiter, 1982). In this study CBEC purchase intention was taken as the response in the research model.

Howard-Sheth Model of consumer behavior

Howard and Sheth put forward a model which describes how people make purchase decisions when they shop for products (Howard & Sheth, 1969). The model assumes that input stimulus and external factors can stimulate purchases, motivate consumers to buy, and then provide them with a variety of information choices that affect their perceptions (internal factors). Consumers are influenced by stimuli, which in turn influence their purchasing decisions. Stimuli include significance stimuli (price, service, etc.), symbolic stimuli (advertising, media, etc.), and social stimuli (family, social group, etc.) (Ma & Li, 2020).

O’Cass and Fenech (2003) proposed that customer involvement in online purchase factors is influenced by external factors such as their characteristics, purchase experience, and product guidance. Cao and Li (2018) pointed out that factors such as the safety of a company's products, reputation, and web interface affect consumers' choice of online travel websites. Ma and Li (2020) suggested factors that affect the purchase intention of cross-border tourism products online contain perceived usefulness, perceived ease of use, product stimulus factor, symbolic stimulus factor, and social stimulus factor, all of which have significant effects on consumers' willingness to purchase online. Therefore, this paper proposes the following hypotheses:

H1a: Significant stimuli positively affect Perceived Risk

H2a: Symbol stimuli positively affect Perceived Risk

H3a: Social stimuli negatively affect Perceived Risk

H1b: Symbol stimuli positively affect Perceived Usefulness

H2b: Significant stimuli positively affect Perceived Usefulness

H3b: Social stimuli positively affect Perceived Usefulness

H1c: Symbol stimuli positively affect Perceived Ease of Use

H2c: Significant stimuli positively affect Perceived Ease of Use

H3c: Social stimuli positively affect Perceived Ease of Use

Technology Acceptance Model (TAM)

Technology Acceptance Model (TAM) was introduced by Fred Davis in 1985 and specifically tailored for modelling users' acceptance of information systems or technologies or new product acceptance. The goal of Davis' TAM is to explain the general determinants of technology acceptance that lead to explaining users' behaviour across a broad range of end-user computing technologies and user populations. The belief of the person towards a system might be influenced by other factors referred to as external variables in TAM. TAM consists of five elements: perceived usefulness, perceived ease of use, attitude toward use, behavioral intentions, and system use. The external variables influence intention to use through perceived usefulness and perceived ease of use, and the actual actions of users are predicted by intention to use. The present study was based on Technology Acceptance Model that was formed by Venkatesh (2000) and Davis who found that both perceived usefulness and perceived ease of use have a direct influence on behaviour intention, thus eliminating the need for the attitude construct. Many researchers have supported that TAM model is proven suitable for measuring the adoption of e-commerce (Chen et al., 2002; Moon & Kim, 2001). Later, the TAM model has been widely used in the study of users' intention to use in the fields of online learning, e-commerce, and online consumer behavior, and the adaptability and reliability of the model have been widely affirmed. The TAM model is used to study users' acceptance and willingness to use cross-border online shopping with certain validity. Li (2014) found that perceived usefulness and ease of use positively affect college students' intention to make mobile online purchases. Li et al. (2016) confirmed with a technology acceptance model that perceived usefulness has a direct positive effect on both users' WeChat shopping attitude and usage behavior. Hence, TAM was used as the basis of the theoretical framework in this study. Both variables in TAM, i.e. *perceived usefulness* and *perceived ease of use*, were included in this study's research model. Therefore, this paper proposes the following hypotheses:

H4: Perceived Ease of Use positively affects Perceived Usefulness

H5: Perceived Usefulness positively affects Purchase Intention

H6: Perceived Ease of Use positively affects CBEC Purchase Intention

Perceived Risk

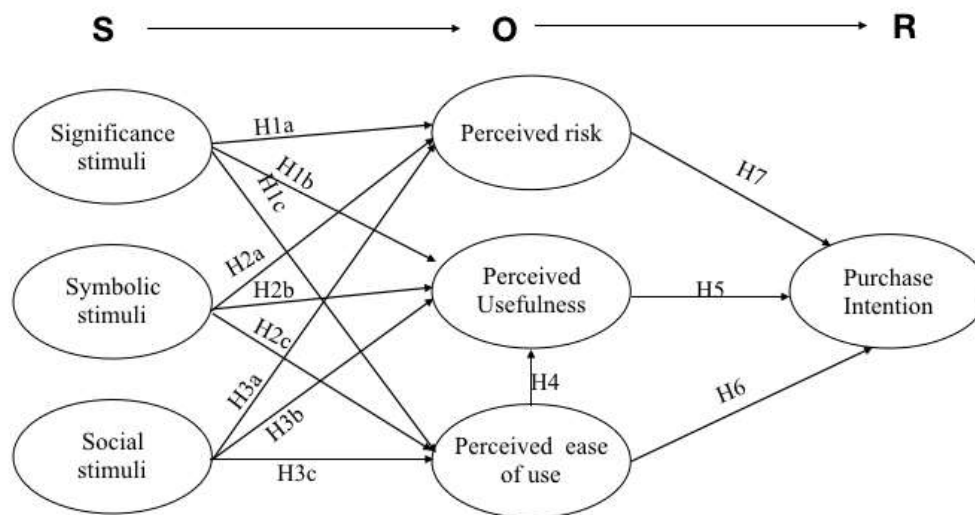
With the emergence of technology, additional variables are introduced to the TAM so as to produce an extended TAM for predicting consumers' intention to use. Perceived risk was first introduced by Bauer (1960) at Harvard University, Bauer defined perceived risk as: the probability of failure of an individual's predicted consumption decisions and the severity of adverse outcomes from the use of these tangible or intangible goods. Jarvenpaa et al. (1996) first included privacy risk as a dimension of perceived risk when they studied online shopping. Since then, many domestic and international scholars have included privacy risk in their research models when studying user behavior in online environments and found that privacy risk has a significant impact on users' behavioral intentions. There are many applications of perceived risk in e-commerce, and many studies have demonstrated its impact on shopping attitude (Yang, Satath&Lee, 2016), purchase intention (Li et al., 2020), satisfaction (Gan & Wang, 2017), etc. Wang et al. (2020) showed through an empirical investigation that perceived risk has a negative relationship with purchase intention. These variables include product involvement (Koufaris, 2002), cost (Shih, 2004) and perceived risk (Pavlou, 2003). Perceived risk is defined as consumers' perceived risk and their own tolerance of risk taking that influence their financial transaction decision (Chan & Lu, 2004). Perceived risk has been shown to reduce consumer's intention to engage internet transactions (Jarvenpaa et al., 2006), which will be the same for CBEC platform that integrates card, internet and mobile transaction. When consumers make CBEC purchases, they have concerns in terms of privacy

disclosure and payment security. Perceived risk suggests the idea that consumers' may be influenced during the CBEC purchase by the feelings like concern of the Covid virus and uncertainty in post-pandemic era in this research. Therefore, *perceived risk* is included to the TAM model in this study. These concerns of users belong to the category of perceived risk, and the following hypotheses is proposed:

H7: Perceived Risk negatively affects Purchase Intention

Research Model

Based on the theoretical models mentioned above, to examine the factors affecting purchase intention of CBEC Consumer in post-pandemic era, this study included significance stimuli(SiS), symbolic stimuli(SyS) and social stimuli(SoS) as input stimulus based Howard-Sheth Model of consumer behavior and S-O-R Model; took perceived usefulness(PU), perceived ease of use(PEOU) and perceived risk(PR) as the perception constructs in organism section; focus on CBEC purchase intention(PI) as response section. Thus, the research model was proposed as follow:



Factors Affecting CBEC Consumer Purchase Intention Model

Figure 1. Research model

DATA COLLECTION AND ANALYSIS

Scale Design

This paper adopts the questionnaire survey method. In order to ensure the authority of each variable definition, through the previous literature review and the specific actual situation of paying for virtual brand community knowledge, this research has made a corresponding variable definition for each variable. In this study, classical scales were referred to, and a predictive test was conducted. According to the feedback of the predictive test, the questionnaire was modified to form the final questionnaire. The research model in this paper has a total of 7 variables with 22 items are set in the questionnaire and measured in the form of a Likert 7-level scale.

Data Collection

The questionnaire is divided into two parts. The first part is of basic personal information, and the second part is the factors affecting purchase intention of CBEC consumers in post-pandemic era. To ensure the rationality and validity of the questionnaire, the questionnaire is distributed in pre-survey stage and formal investigation stage. At the pre-survey, 110 questionnaires were distributed, and the data were used to modify the questionnaire. The collected data are analyzed by SPSSAU for the reliability and validity of the questionnaire. According to the corresponding feedback, the content and structure of the questionnaire are enriched and improved to ensure the scientificity and validity of the final questionnaire. During the formal survey period, 400 questionnaires were distributed and total of 322 valid questionnaires were obtained after eliminating the invalid questionnaires. According to the statistics, 90% of the respondents who participated in the questionnaire were female, and the age group below 45 years old was dominant; those with college and bachelor's degree accounted for the majority; those with a monthly income of 3,000-8,000 yuan accounted for 50%; the annual expenditure on CBEC was 1,500-8,000 yuan, accounting for 89% in total.

Test of Reliability and Validity

The reliability and validity test results of the questionnaire on factors affecting purchase intention of CBEC consumer in Post-pandemic era can be found in Table 1. AVE and CR were used for convergent validity analysis; usually an AVE greater than 0.5 and a CR greater than 0.7 indicated high convergent validity. Composite AVE ranging from 0.628 to 0.730 means the validity of the analysis is adequate. CR indices of measurement items in this study are higher than 0.7, suggesting good internal consistency and reliable analysis results. Cronbach's α stands for the extent of the close relationship of items in a

group, and is used to measure the scale reliability of the items. When Cronbach's α is higher than 0.8, it implies that the items have a relatively high internal consistency.

Table 1: Test of reliability

Construct	AVE	CR	Cronbach's α
SiS	0.661	0.886	0.881
SyS	0.632	0.784	0.817
SoS	0.711	0.880	0.877
PR	0.628	0.796	0.822
PU	0.602	0.819	0.816
PEOU	0.730	0.890	0.889
PI	0.669	0.858	0.858

The validity analysis of all the measures shown in Table 2 suggests that the KMO value of the overall scale was greater than 0.8, and the significance of Bartlett's spherical test value was less than 0.001, indicating that the study data had good validity and reached a significant level.

Table 2: Test of KMO and Bartlett

KMO		0.849
	Chi-square	362.335
Bartlett's Test	<i>df</i>	21
	<i>p</i>	0.000

Test of Model Fitness

Table 3: Model fitness

Indicator	χ^2/df	GFI	RMSEA	AGFI	CFI	NFI	NNFI
Std. value	<3	>0.9	<0.10	>0.9	>0.9	>0.9	>0.9
Value	2.047	0.913	0.080	0.932	0.917	0.923	0.901

The model fitness value in Table 3, $\chi^2/df=2.047 < 3$, GFI= 0.913, RMSEA=0.080, AGFI=0.932, CFI=0.917, NFI=0.923, NNFI=0.901, implying that the model is statistically significant and worth being further analyzed.

Table 4: Path coefficients

X	→ Y	Unstd. Coef	SE	<i>z</i> (CR)	<i>p</i>	Std. Coef	Conclusion
SiS	→ PR	0.271	0.061	2.976	0.006	0.312	Support
SyS	→ PR	0.529	0.100	5.299	0.000	0.540	Support
SoS	→ PR	-0.050	0.082	-0.618	0.000	-0.057	Support
SiS	→ PU	0.306	0.077	3.956	0.000	0.287	Support
SyS	→ PU	0.432	0.063	2.794	0.027	0.488	Support
SoS	→ PU	0.145	0.057	2.545	0.011	0.154	Support
SiS	→ PEOU	0.455	0.096	4.727	0.000	0.396	Support
SyS	→ PEOU	0.283	0.091	3.118	0.002	0.249	Support
SoS	→ PEOU	0.188	0.074	2.524	0.012	0.184	Support
PEOU	→ PU	0.420	0.059	7.130	0.000	0.453	Support
PR	→ PI	-0.107	0.066	-1.633	0.008	-0.088	Support
PU	→ PI	0.377	0.092	4.083	0.000	0.334	Support
PEOU	→ PI	0.525	0.086	6.127	0.000	0.501	Support

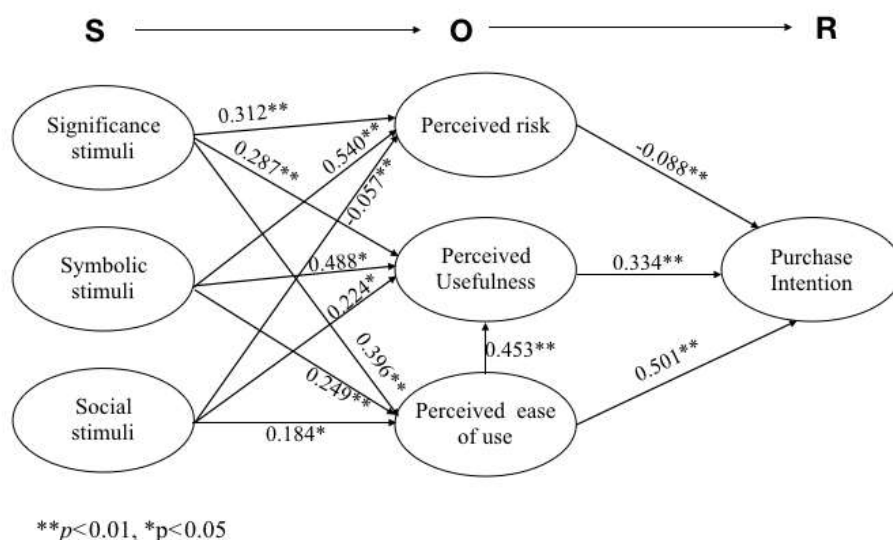
Table 4 shows the path coefficients and the structural relationships of the model, which include the unstandardized path coefficient (Unstd. Coef.), standard error (SE), *z* values (CR), the corresponding significance of the effects (*p* values), standardized path coefficient (Std. coef) and conclusions of support for each hypothesis.

Specifically, SiS has a standardized path coefficient value of $0.312 > 0$ for PR influence and this path shows a significance at 0.01 level ($z=2.976$, $p=0.006 < 0.01$), thus indicating that SiS has a significant positive influence on PR; SyS has a standardized path coefficient value of $0.540 > 0$ for PR influence and this path shows a significance at 0.01 level ($z=5.299$, $p=0.000 < 0.01$), thus indicating that SyS has a significant positive influence relationship on PR; SoS has a standardized path coefficient value of $-0.057 < 0$ for PR influence and this path shows a negative significance at 0.01 level ($z=-0.618$, $p=0.000 < 0.01$), thus indicating that SoS has negative influence relationship on PR; SiS has a standardized path coefficient value of $0.287 > 0$ for PU influence and this path shows a significance at 0.01 level ($z=3.956$, $p=0.000 < 0.01$), thus indicating that SiS has significant positive influence relationship on PU; SyS has a standardized path coefficient value of $0.488 > 0$ for PU influence and this path

shows a significance at 0.05 level ($z=2.794$, $p=0.027<0.05$), thus indicating that SyS has significant positive influence relationship on PU; SoS has a standardized path coefficient value of $0.154>0$ for PU influence and this path shows a significance at 0.05 level ($z=2.545$, $p=0.011<0.05$), thus indicating that SoS has significant positive influence relationship on PU. SiS has a standardized path coefficient value of $0.396>0$ for PEOU influence and this path shows a significance at 0.01 level ($z=4.727$, $p=0.000<0.01$), thus indicating that SiS has significant positive influence relationship on PEOU; SyS has a standardized path coefficient value of $0.249>0$ for PEOU influence and this path shows a significance at 0.01 level ($z=3.118$, $p=0.002<0.01$), thus indicating that SyS has significant positive influence relationship on PEOU; SoS has a standardized path coefficient value of $0.184>0$ for PEOU influence and this path shows a significance at 0.05 level ($z=2.524$, $p=0.012<0.05$), thus indicating that SoS has significant positive influence relationship on PEOU. As a result, hypotheses H1a, H1b, H1c, H2a, H2b, H2c, H3a, H3b and H3c were supported.

PEOU has a standardized path coefficient value of $0.453>0$ for PU influence and this path shows a significance at 0.01 level ($z=7.130$, $p=0.000<0.01$), thus indicating that PEOU has significant positive influence relationship on PU; PU has a standardized path coefficient value of $0.334>0$ for PI influence and this path shows a significance at 0.01 level ($z=4.083$, $p=0.000<0.01$), thus indicating that PU has significant positive influence relationship on PI; PEOU has a standardized path coefficient value of $0.501>0$ for PI influence and this path shows a significance at 0.01 level ($z=6.127$, $p=0.000<0.01$), thus indicating that PEOU has significant positive influence relationship on PI; As a result, hypotheses H4, H5 and H6 were supported.

PR has a standardized path coefficient value of $-0.088<0$ for PI influence and this path shows a negative significance at 0.01 level ($z=-1.633$, $p=0.008<0.01$), thus indicating that PR has negative influence relationship on PR. As a result, hypotheses H7 was supported.



Factors Affecting CBEC Consumer Purchase Intention Model

Figure 2. Test result of research model

Based on the test result of research model, it is apparent that all the hypotheses are verified. In the context of post-pandemic, significance stimuli, symbolic stimuli and social stimuli have positive influence on perceived usefulness and perceived ease of use; social stimuli have negative influence on perceived risk; perceived usefulness and perceived ease of use have positive influence on CBEC purchase intention while perceived risk has negative influence on purchase intention.

CONCLUSION AND SUGGESTIONS

Significance stimuli

From the perspective of significance stimuli, besides to ensure the quality and diversity of goods, CBEC platforms should seize the opportunity to take advantage of the channel to ensure a balance between supply and demand of goods and services, and enhance the ability to respond to the synergy of goods on display, packaging, distribution.

Symbol stimuli

During the post-pandemic era, new users are attracted to the CBEC platform, and it is crucial to managing these new users well. Discount offers and holiday promotions campaigned via different channels are two important types of activities that attract consumers. Consumers consider price to be the most important factor among the many advantages of CBEC consumption. From the perspective of symbol stimuli, the platform should consider pushing specific products and preferential discounts for new users, and at the same time carry out differential management strategies for old and new users to increase customer stickiness and give full play to the scale effect of new users pulled during the post-pandemic era to continuously accumulate resources and retain users.

Social stimuli

As consumers become more sophisticated and selective, it becomes increasingly difficult for them to become loyal users of platforms. From the perspective of social stimuli, product quality is the main content of social evaluation and the root of business reputation. The quality of products must meet or exceed consumers' psychological expectations in order to satisfy consumers and generate positive word-of-mouth publicity. In the context of epidemic prevention and control, CBEC consumers are more likely to obtain and spread word-of-mouth messages through online information and other Internet means, so platforms should make efforts to win over the market by making good use of product packaging and display as well as promotional strategies. When the product meets the consumer's needs and establishes a certain emotional base with the consumer, it is easier to obtain good word-of-mouth publicity and increase purchase intention.

Perceived risk

Consumers will give priority to the safety of consumption in the case of information inequality. From the perspective of perceived risk, CBEC platform should strengthen the supervision of the platform, increase the management of industrial integrity, establish an information management system by big data to strengthen the prevention of credit risk. At the same time, establish channels to defend rights of consumers while expose the default platform to promote the healthy development of the e-commerce industry .

Perceived usefulness

From the perspective of perceived usefulness, CBEC industry should expand the cooperation platform and channels to ensure consumers with satisfactory supplies and services, while focusing on product packaging and pushing new products with high frequency to drive sales growth while tapping more potential customers.

Perceived ease of use

From the perspective of perceived ease of use, CBEC platform should improve the online and offline service level. Customer service is required to respond to customers' questions in a timely manner and give effective answers. Setting up special channels for consultation, inquiries and complaints, and protecting the basic rights and interests of consumers, so as to lay a solid foundation for creating a good CBEC purchasing environment.

Research Limitations and Future Prospects

This paper mainly studies the factors affecting purchase intention of CBEC consumer in post-pandemic era. Although some conclusions have been drawn, there are still deficiencies in many aspects of research. The following summaries are made, and prospects are made for subsequent studies.

In this study, due to the many limitations of sample collection, most of the survey subjects involved are from Hubei Province, China and there is a certain proportion of imbalance. It will affect the research conclusions to a certain extent, and the sample interpretation ability needs to be improved. In future studies, the range of samples can be expanded to make research results more representative and accurate, and big data can also be used to obtain more data support to enhance the scientific nature of the research.

This study selected limited variables when constructing a model of the factors affecting purchase intention of CBEC consumer in post-pandemic era. There are many different influencing factors of purchase intention to participate in different contexts. This study only considers some variables in the context of CBEC consumers in post-pandemic era, and the selection of model variables is insufficient. In addition, the actual factors such as the personal characteristics and profession of the participating users will also affect the purchase intention to a certain extent. This is not considered in this study, and the population is not distinguished. In future research, more relevant factors will be introduced in the research content, and the research model will be continuously improved, with a view to drawing more representative research conclusions and more comprehensively exploring the factors affecting the factors affecting purchase intention of CBEC consumer in post-pandemic era.

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Buying behavior during online visits at two retail websites: Possible effects of COVID-19

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ABSTRACT

For two years has COVID-19 brought chaos to the world. While there has been remark on its effect on online retail transactions, there is no empirical work gathering actual buying behavior to verify it. Hence, the current research's goals are to use panel data at two online retail stores and subsequently to compare two buying variables between those in 2019 when the pandemic was not known and those in 2020 when it was officially confirmed. The study gathered usable 69,397 transactions at Walmart.com and Bestbuy.com during the two years. The comparisons of the basket value and the purchased units between the two years confirmed in part the significant effects of COVID-19 on the two buying behaviors.

Keywords: Basket Value; Purchased Units; COVID-19; Online Retail Transactions.

INTRODUCTION

Since the first confirmed case at the end of 2019 followed by the substantial number of fatalities, COVID-19 has had a massive impact on human. The largest one could be on how we must live our lives under the new normal condition. In March 2020, nearly all health management organizations had to officially confirm the pandemic and to provide guidelines to the public in order to minimize the health crisis. Governments around the world must balance their effort to alleviate the health problem and to resuscitate the economic downturn.

People are supposed to follow the public announcements closely and to observe certain measures to manage their own safety. Such announcements cover how people could get vaccinated, or how long a lockdown period will be. Many restrictive policies have been enforced including residents having to wear proper masks in the public area, workers working from home using network applications, or corporate decision to slash down executives' salary, or to layoff sizable portions of staff. Vietnamese people, for example, have lived their lives by themselves in order to keep members of families safe from COVID-19 and their daily accomplishments were mainly done via online channels (Nguyen, et al., 2021). These examples have validated that the online behavior has been intense since March 2020 when the world officially experienced COVID-19.

Because of the pandemic, the high volume of business transactions had been disrupted. Investigations on its effects cover various issues ranging from general purchasing behavior to online buying transactions to online purchase of specific items such as medical supplies or groceries (Chang & Meyerhoefer, 2021; Boyle, et al., 2022; Gu, et al., 2021). For instance, during the lockdown, many residents of Oman purchased their groceries online (Al-Hawari, et al., 2021). A review of previous literature addressing the pandemic effects on online retail transactions reveals major limitations. They may have validity problems when collecting basket values during visit sessions. In general, people are sensitive if asked about their financial amounts. Also, no specific work testing possible effect of COVID-19 on buying behavior at retail websites is found. Hence, our main objective is to test if visitors' buying behavior during their visits at retail websites are changing, perhaps, due to COVID-19.

LITERATURE REVIEW

COVID-19 has disrupted the world enormously. An airplane pilot known as one of the most secured careers has been suspended indefinitely. People are instructed and later enforced by law to stay isolated from, or to have little physical interaction with, the others. This is one of the key measures to control the spread of the pandemic. In early 2020, the world was alarmed by a mysterious disease that attacks a person's upper respiratory system and spreads easily through personal physical contact. Until the early 2021 when the first dose of vaccine was introduced, the situation appeared to have no solution. However, the arrival of Omicron in early 2022 has delayed the triumph over the pandemic.

Online retail is no exception. Given little physical contact we must have, an online platform has been the best communication channel during the pandemic. According to Gu, et al. (2021), web-based businesses have been drastically increased. Yet, the growth as measured by the increased basket value or the high number of purchased items per visit has never been addressed. Because of COVID-19, Vietnamese prefer to do online shopping for the health-related concern (Nguyen, et al, 2021). Using transactional data from one UK-based retail website, Boyle, et al. (2022) verified that the basket value during the lockdown in UK was significantly higher than that outside the period. However, England experienced multiple slots of lockdown so this work may not be the test of the COVID-19 effect on spending amounts at the website. Nonetheless, the online transactions with the average basket size of 30 pounds or less was only 1% in 2019 when the world was free from COVID-19, but it was

7% in 2020 when the pandemic was officially confirmed. Such sharp increase could be due to the COVID-19 (Boyle, et al., 2022).

Using data from one retail website in Taiwan, Chang and Meyerhoefer (2021) found that the pandemic had contributed to the substantial increase in food purchase through online channels. According to the survey in Pitts (2022), American shoppers in rural areas did grocery shopping during the COVID-19 significantly less than those in urban cities. The reason behind this finding could be those in rural areas have access to the grocery supply through many more channels than the online ones as compared to those living in the urban area. Tangmanee and Iam-Opas (2022) analyzed the panel data from two retail websites and confirmed that retail shoppers had significantly larger basket amounts in 2020 than those in 2019. However, they failed to address the number of purchased items in one visit session. Using interviews, Al-Hawari, et al. (2021) revealed that shoppers in Oman mainly shifted from the offline to the online channels for health-related reason. Changes in online purchasing behavior perhaps due to COVID-19 was also evident in Sayyida, et al. (2021, p. 2266). People whose income became limited abruptly because of the pandemic admitted that they had longer visit sessions in search of the products that suit their budget. Nonetheless, their purchase volumes per visit were less during the COVID-19 than during the period when it was not recognized (Sayyida, et al., 2021). In early 2022, Omicron (i.e., the recent mutation of COVID-19) had arrived. It caused the new wave of fatalities, despite many predictions in which it could be the final stage of the pandemic. The only effective preventive measures are to be vaccinated and to maintain social distancing from the others.

Electronic commerce scholars have remarked that the effects of COVID-19 on the transactions at online retail stores (Gu, et al, 2021; Boyle, et al., 2022; Nguyen, et al., 2021). Such remarks have been on the general purchase (Sayyida, et al., 2021; Alam, 2020) and on the specific purchase of the four items including groceries (Chang & Meyerhoefer, 2021; Macdonald, 2020; Gu, et al., 2021), sports items (Gu, et al., 2021), fashion and apparels (Nguyen, et al., 2021) and jewelry or watches (Nguyen, et al., 2021; Gu, Et al., 2021). For instance, it is speculated that more groceries were bought online during the COVID-19 than those before its time (Macdonald, 2020). For the luxurious items, the pandemic should not accelerate the sale since the other products such as medical supplies deserve higher purchasing priority.

Despite the past research, three research gaps were identified. First, the large portion of previous literature has addressed the impact of COVID-19 on online transactions using a survey approach. While valid, a questionnaire asking subjects to recall their online behavior appears problematic. This is because visitors may be unable to recall what they have done during the visit, or it is difficult to verify if their responses to the survey are genuine. A visit to pornography websites (Tangmanee, 2017) may be the example when visitors want to keep the visit detail to themselves. Second, a fair number of publications have used secondary data including the panel detail or the store transaction data (Boyle, et al., 2022). The only minor defect in using the panel data is that their main purposes were not to examine the effect of COVID-19 on online transactions. Finally, there is no specific work that directly inspects how visitors spend money during their visit sessions at retail websites or attempts to verify if there are the pandemic impacts on the basket amounts. As a result, our objectives are to compare two buying variables in 2019 when the world was free from COVID-19 to those in 2020 when it was officially confirmed. The two variables are the basket value (BV) in US dollars and the number of units purchased in one visit session (NU) at retail websites. These two buying variables are of our interest for two reasons. First, the basket value is of an online store's central concern. Yet, no seller wants to share the value publicly. We are fortunate to have it from a reliable source. Second, no study has examined the number of purchased units per visit. In this study, it is defined as the total number of all units a visitor purchased during his or her visit session. The unit can be varied depending on the product type or its packaging. A purchase of detergent may have a unit of a box or that of a pack while liquid soap could be a bottle or a gallon. In addition to the total comparison, we also performed similar comparison of the buying variables in four product categories: groceries; sport items; fashion and apparels; and jewelry and watch.

RESEARCH METHODOLOGY

Research Approach and Data Preparation

To gather the basket value (BV) which retail website visitors spent and the number of units purchased (NU) in one visit session, we obtained the session-level household panel data from the comScore service. It has been subscribed by Chulalongkorn Business School in Thailand. Managed by Wharton Business School at the University of Pennsylvania, the service obtained permission to record a member's visit behavior at many websites including online retail stores. We are particularly interested in two retail websites: Walmart.com and Bestbuy.com. We selected these two for their wide acceptance as they have been listed among the world's top ten retail websites (Ecommerce guide, 2022; Similarweb, 2022). We deliberately exclude Amazon.com, despite its dominance in online retailing, because it has already been examined heavily while Walmart.com or Bestbuy.com was overlooked.

We extracted the detail of the visits to the two websites only if the visitors had purchased at least one unit of any product during their visit sessions. As such, a unit of analysis is an actual transaction made during his or her visit. Our data collection covers all visits from January 1, 2019, to December 31, 2020. We treated the data in 2019 as the buying behavior before the pandemic was still unknown and those in 2020 as the buying behavior when the disease was officially confirmed. In each collected visit session, we recorded the product name, the product category, the number of purchased units (NU), and the basket value (BV), together with the comScore member's demographic details. Based on the collected demographics of the participating shoppers at Walmart and BestBuy in 2019 and 2020, they all reside in the US. The buying behavior thus reflects

those of the US residents. 43% of the participating shoppers are seniors over 60 years of age. 70% have the household size of three members or less. 6 in 10 have the annual income of at most US\$ 60,000 and 5 in 10 live in the south.

Data Analysis

To detect the possible effect of COVID-19 on BV and NU, we used the independent t-test to compare these two variables between those in 2019 and in 2020. The comparisons were on the total purchase and the purchases of the four product categories.

RESULTS

The two-year data extraction from Walmart and BestBuy yielded the large dataset of 89,157 online transactions. Since we are interested in the purchases of the four product categories, we selected them using the comScore's product categories scheme. It resulted in the dataset of 69,397 records for the subsequent analyses. Based on Table 1, the online transactions in 2020 when COVID-19 was confirmed appeared more frequent than those in 2019 when the disease was not known yet. Also, as expected, the sessions at Walmart were larger than those at BestBuy. Table 2 reports the frequency of all 69,397 records classified by the years, the product categories and the retail websites. The data still fall in the same direction as those in Table 1.

Table 1: Frequency distribution of key variables (n=69,397)

Variables	Value	Counts (%)
Product categories	Groceries	43,593 (62.8)
	Sports items	3,856 (5.6)
	Fashion and apparel	20,206 (29.1)
	Jewelry and watches	1,742 (2.5)
Year	2019	17,348 (25.0)
	2020	52,049 (75.0)
Retail websites	Walmart.com	48,988 (70.6)
	Bestbuy.com	20,409 (28.4)

Table 2: Frequency of transactions classified by the product categories, the retail websites and the years.

Product Categories	Retail websites				Total
	Walmart		BestBuy		
	2019	2020	2019	2020	
Groceries	7,408	23,819	2,680	9,686	43,593
(row %)	(17.0)	(54.6)	(6.1)	(22.2)	(100)
(column %)	(58.2)	(65.7)	(58.1)	(61.3)	(62.8)
Sports items	1,088	2,687	25	56	3,856
(row %)	(28.2)	(69.7)	(0.6)	(1.5)	(100)
(column %)	(8.5)	(7.4)	(0.5)	(0.4)	(5.6)
Fashion	3,981	8,941	1,761	5,518	20,206
(row %)	(19.7)	(44.3)	(8.7)	(27.4)	(100)
(column %)	(31.3)	(24.7)	(38.2)	(34.9)	(29.1)
Jewelry	262	797	143	540	1,742
(row %)	(15.0)	(45.8)	(8.2)	(31.0)	(100)
(column %)	(2.1)	(12.2)	(3.1)	(3.4)	(2.5)
Total	12,739	36,249	4,609	15,800	69,397
(row %)	(18.3)	(52.2)	(6.6)	(22.8)	(100)
(column %)	(100)	(100)	(100)	(100)	(100)

Reported in Table 3 are descriptive statistics of BV and NU, classified by the four product categories. During 2019 and 2020, shoppers at Walmart and BestBuy spent 89.51 US\$ to purchase 1.35 units per visit session in average. Among the four product categories, they paid the highest amount of 149.15 US\$ for sports items with the average number of 1.43 units per visit. The other three categories were bought at the comparable amounts of BV. Considering NU, the average number of the units purchased are in between 1.6 to 1.54 units per visit. This is regardless of what the products are. Also in Table 3, the absolute values of the skewness and the kurtosis statistics are all greater than one. They signify that both BV and NU are not normally distributed. We thus used the natural logarithm function to transform them, after which their distributions appear normal, and a parametric test can be used for the comparisons.

To detect the possible effect of COVID-19 on BV and NU, we used the independent t-test to compare those in 2019 and in 2020 and the outcomes are in Table 4. In total, the BV in 2020 was significantly higher than that in 2019 ($p = .000$). A look at the four product categories shows that (1) the BV of the groceries and that of the fashion categories in 2020 are significantly higher than those in 2019 (p -values = .000) but those of the sports items (p -values = .189) and those of the jewelry (p -values = .168) in 2019 and in 2020 are about the same.

Table 3: Descriptive statistics of the basket value (BV) and the number of purchased units (NU) per visit session

Product categories	Average	Standard deviation	Skewness	Kurtosis
Groceries (n=43,593)				
BV	83.68	137.816	15.575	385.374
NU	1.43	1.715	27.036	1,378.101
Sports items (n=3,856)				
BV	149.15	427.196	17.642	440.828
NU	1.54	5.673	22.106	575.221
Fashion and apparels (n=20,206)				
BV	90.66	142.724	18.496	582.143
NU	1.16	0.886	43.879	3,806.081
Jewelry and watches (n=1,742)				
BV	90.01	108.587	3.367	15.059
NU	1.18	0.813	8.398	87.741
Total (n=69,397)				
BV	89.51	168.863	24.793	1,222.679
NU	1.35	1.975	41.580	2,733.865

In Table 5, we performed the similar tests but on NU. In total, the number in 2020 is significantly larger than that in 2019 (p -value = .000). Considering the four categories, only the NU of the fashion group in 2020 is significantly larger than that in 2019 (p -value = .000). The comparisons on the other three groups show no significant findings.

Table 4: Comparison of means of the basket value (BV: US\$) between 2019 and 2020

Product categories	Means in 2019	Means in 2020	Testing statistics (df)	P-value (One-tailed)
Groceries	82.76	83.96	-3.987 (15,806.15)	.000
Sports items	124.38	159.20	-0.881 (3854)	.189
Fashion and apparels	83.39	93.55	-4.144 (11,236.82)	.000
Jewelry and watches	88.87	90.36	-0.961 (629.57)	.168
Total	85.78	90.75	-4.822 (29,309.41)	.000

Table 5: Comparison of means of the number of purchased units per visit (NU: items) between 2019 and 2020

Product categories	Means in 2019	Means in 2020	Testing statistics (df)	P-value (One-tailed)
Groceries	1.45	1.43	-0.361 (43591)	.360
Sports items	1.42	1.58	-0.813 (3854)	.208
Fashion and apparels	1.13	1.17	-3.587 (11,764.6)	.000
Jewelry and watches	1.21	1.17	0.590 (1740)	.277
Total	1.34	1.36	-3.809 (30,746.76)	.000

CONCLUSION AND DISCUSSIONS

Using the panel data from comScore, we gathered 69,397 actual transactions at Walmart.com and Bestbuy.com during the two years of 2019 and 2020. 25% of the collected transactions were from 2019 when the world was unaware of COVID-19 and the rest were from 2020 when the pandemic was officially confirmed. The relatively high number in 2020 is likely to result from the pandemic during which folks around the world were instructed to work from home or to minimize a physical contact with the others. Given the business volume of Walmart and BestBuy, it can be expected that 71% of the collected transactions were from the former and the rest from the latter. The demographics (e.g., age groups, annual income, or household sizes) greatly tap the profiles of the American online retail shoppers (Similarweb, 2022).

The basket value per transaction observed in the current research is approximately 89.51 US\$. Tangmanee and Jongtavornvitaya (2022) reported the basket value of 77.86 US\$ per session at Amazon.com. While Amazon's basket value was slightly less than our findings, it is possible since the sessions in Tangmanee and Jongtavornvitaya (2022) included those sessions with transactions and those without the transactions. Nonetheless, we offer no discussion regarding the number of units for which shoppers had made a purchase during their visits. This is because there is no published work in the past that reported this buying variable. We further encourage scholars to include it in their studies.

The comparisons of whether the total of BV and NU in 2019 were less than those in 2020 confirmed the significant findings. In other words, once the pandemic was recognized, BV and NU were significantly increased (see Tables 4 and 5 for details). This could be an empirical validation of the COVID-19 effect on online retailing. Our findings are also in line with previous work (Nguyen, et al., 2021; Al-Hawari, et al., 2021; Boyle, et al., 2022).

When the similar comparisons were performed on the four product categories, the findings added new exciting facets. First, the pandemic may force individuals to do more of grocery shopping online. This is because the grocery purchase's BV in 2020 was significantly higher than that in 2019. This is an empirical addition to previous work which discovered the increase in online grocery shopping possibly because of the pandemic (Nguyen, et al., 2021; Chang & Meyerhoefer, 2021). Nevertheless, NU of the grocery shopping was not significant between these two years. It may have to do with a variety of how the units of grocery shopping are measured. It could be a bag of fruit, a carton of milk or one kilogram of meat. Yet, this is our speculation awaiting additional empirical work.

Second, the two buying behaviors of online fashion shopping in this study has validated the effect of COVID-19 on online purchasing behavior. That is, BV and NU in this category in 2019 is significantly less than those in 2020. These findings lie in the same direction as the comparison outcomes when all four product categories are combined. Initially, we expected the insignificant findings because people must stay home for the pandemic. They should not be in need of shopping for new clothing. However, our comparisons validated that people did more online shopping for fashion and accessories when the pandemic were officially recognized than when the world was free from it. Our conjecture would be people may consider online shopping of this category as a recreation from staying home all the time. Nonetheless, we need more empirical work to verify it.

Third, the comparisons of BV and NU in 2019 for online retail shopping of sports items and those in 2020 were not significant. Based on Gu, et al., 2021, sports products should be in great need during the lockdown. This is because individuals are unable to visit a gym or a park for routine workout. Hence, they have to purchase sports items of their choices to have a session at home. However, the data in our study fail to verify Gu, et al. (2021)'s claim. We suspect that shoppers who participated in our research may not have an active workout lifestyle. As such, they have no problem staying (or working from) home without the workout or they might be able to figure out how to do the workout at home without the need to purchase extra sports items.

Finally, the comparison outcomes of BV and NU in 2019 for online shopping of jewelry and watches and those in 2021 were trivial. Previous research (Nguyen, et al., 2021; Gu, et al., 2021) has remarked that many firms have cut-off their staff's salary in order to survive the difficult time of COVID-19. The staff may suddenly be on limited budget and must subsequently watch out their expenses carefully. Such luxurious items like jewelry or watches may receive less attention during the pandemic than before its time. Still, the data in this research fail to verify this statement, possibly, because BV and NU of such shopping in 2019 and in 2020 are about the same. Our discussion on the insignificant finding may be due to the fact that general shoppers at Walmart or BestBuy may not be the targets of such luxurious items as jewelry or watches (Pitts, 2022). Our guess is based on the small proportion (2.5%) of jewelry shopping in our dataset (see Table 1 for details).

Our findings have both theoretical and practical contributions. Theoretically, they provide validation for which COVID-19 appears to have impact on online retail, especially the basket value of the grocery and the fashion shopping. A look at all four product categories, the significant differences of the basket value and the purchased units between those in 2019 when COVID-19 was still unknown and those in 2020 when it was officially confirmed could be the other validation. However, the effect of the pandemic on the online retail of the sports items or the jewelry products need additional evidence since our findings are unable to validate it. This is in the opposite of the remark made by a few online retail scholars (Nguyen, et al., 2021; Sayyida, et al., 2021). The second theoretical contribution is that our analytic outcomes can confirm the moderation of product categories on the correlation between the pandemic effect and the online retail behavior. In other words, researchers must observe the distinctive effects of COVID-19 on various types of online retail products. For instance, people must acquire a large volume of medical supplies after the disease was recognized. Yet, this statement still needs empirical validation.

Our findings offer two practical contributions. First, online retailers should feature the product categories, of which the sale volume has been significantly increased because of COVID-19. Grocery online merchants, for example, must ensure their online stores' proper functionality to accommodate large groups of shoppers during a lockdown. Second, online retailers of sports items may be on alert since the lockdown may not drive people to do more shopping on this workout equipment. However, we contemplate that the target of these sports items may not have their transactions at Walmart or BestBuy. Practitioners have to accurately recognize their target groups.

Our research does have limitation for its own scope. Our analytic outcomes and discussions are based on the online transactions of the four product categories at Walmart and BestBuy during 2019 and 2020. Although valid, they do not allow us to offer insights beyond this scope. Hence, fellow researchers are welcome to do similar projects on different settings.

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Digital financial literacy as a business model: The case study of a FinTech start-up

(Work-in-Progress)

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ABSTRACT

Despite the increasingly significant role of Financial Technology (FinTech) in achieving social inclusiveness and the rapid development of digital financial services, digital financial literacy remains a key obstacle realizing the full potential of FinTech and its associated services. Departing from the limited and generic extant research on individual users, this article focuses on the perspective of financial institutions by utilizing a case study method from the organizational perspective. It examines the manner in which digital financial literacy can be leveraged as the business model of a FinTech start-up to promote both business and societal development.

Keywords: Digital, Financial Literacy, Business Model, FinTech, Case Study.

INTRODUCTION

Financial Technology (FinTech) plays a pivotal role in enabling sustainable and inclusive financial capability development (Panos and Wilson, 2020). Digital financial services, including internet and mobile financial services, have become critical drivers of a vibrant economy, by generating employment, driving productivity, fostering entrepreneurship, and maintaining economic resilience (Toronto Centre, 2022). Such drivers are especially pertinent amidst the COVID-19 pandemic as such digital services and their business models become ubiquitous.

A significant obstacle in realizing societal gains from FinTech is the level of digital financial literacy. The OECD 2020 International Survey of Adult Financial Literacy finds that although vulnerable groups, such as young adults (18-29) have high digital literacy, this is not the case with their financial literacy (OECD, 2020). As digital financial services become more prevalent and easily accessible, it can only be assumed that digital financial literacy will become key to supporting financial inclusion and security (Grohmann et al., 2018). Despite the steady progression being obtained and the promising vision of the future, a number of hindrances are being identified, which together prevent the full potential of digital financial services from being promptly and properly unleashed (Philippas and Avdoulas, 2020). In particular, we aim to examine the case of a FinTech start-up whose strategic goal is to increase their customers' digital financial literacy. This leads to the key research question that will be explored in the research: *how can a financial provider leverage its business model to improve the digital financial literacy of its individual customers?*

RESEARCH BACKGROUND

Deriving from digital literacy and financial literacy scholarly literature, digital financial literacy is largely understood as "the application of digital literacy and financial literacy to enable the use of digital financial services" (Toronto Report, 2022). It is widely believed that digital financial literacy enables sound financial decisions (Balasubramnian and Sargent, 2020), informed financial plans (Artavanis and Karra, 2020), and robust financial well-being (Philippas and Avdoulas, 2020). Similar to studies on digital and financial literacy, digital financial literacy places emphasis on knowledge-based awareness and skills (Lyons and Kass-Hanna, 2021). Lyons and Kass-Hanna's (2021) synthesis, however, has also made digital financial literacy display its uniqueness due to the nature of its provisions and implications. Given the rapid proliferation of FinTech during the COVID-19 pandemic, consumers face increasingly complex financial provisions channeled through digital media (Fu and Mishra, 2022). This, therefore, suggests that digital financial literacy is a multi-dimensional concept – apart from encompassing digital literacy and financial literacy, it entails a holistic appreciation of the digitally enabled and financially laden services and decisions.

From a practical perspective, despite the widely-accepted importance of digital financial literacy, general financial literacy in EU countries is short of being substantial. According to the 2021/22 Young Persons Money Index (The London Institute of Banking and Finance, 2022), 72% of those surveyed would be keen to learn more about finance and 81% were learning about relevant knowledge at home. This echoes with the report from The UK Financial Capability (Financial Capability, 2022) that more than a third of adults in the UK do not feel confident in managing money, and around a fifth rarely or never save. While

FinTech is revolutionizing the financial landscape at an unparalleled pace (Frost et al., 2019) by de-centralizing the financial structure and streamlining the financial processes (Vučinić, 2020), it may also unwittingly impact users' financial behaviors and decisions. Panos and Wilson (2020) summarize that mobile users are more likely to engage in impulsive purchasing behavior and use payday loans, which are often overly accessible and allow fleeting preferences to be acted upon. Similarly, Panos and Karkkainen (2019) identify that cryptocurrencies attracted a multitude of investors who were less cognizant of the potential risks and possible trade-offs, likely resulting in its volatility. As a result, a more holistic perspective offers that customers increasingly face barriers. Such barriers range from the limited provisions for the development of financial knowledge and skills, the wide variety of FinTech products, to the complexity of digital offerings, and the existence of accessibility and feasibility gaps. All barriers that are inherently digital-borne and intrinsically finance-oriented.

Regardless of the increasing impact that digital financial literacy has on vulnerable groups, there is limited extant research. Most existing studies focus either on digital literacy (e.g., Park et al., 2021; Polizzi, 2020) or financial literacy (e.g., Hussain et al., 2018; Klapper and Lusardi, 2020) rather on specifically examining digital financial literacy and its unique factors. Of those, the available studies on digital financial literacy are examined from the individual perspective. For example, descriptive summaries of end-users (Azeez and Akhtar, 2021), documentation of the ongoing concerns of the general public (Morgan et al., 2019), and proposed remedial measures individuals may conduct (Setiawan et al., 2020).

However, we propose to turn our attention to the supply-side, the financial institutions. We argue that digital financial literacy can be better understood as a systems-level concept (Zott et al., 2011) – a unique business model. In particular, we focus on FinTech start-ups as key stakeholders of the digital financial services ecosystem (Lee and Shin, 2018). Such business models are surprisingly understudied and further examination can warrant understanding on their role in promoting digital financial literacy amongst its users.

In fact, financial providers have strategised digital financial literacy as a fundamental factor in their long-term business success (e.g., BBVA, ANZ, Discovery Bank) in response to customers' expectations. Following the initiatives of sustainable and inclusive finance, individuals envisage a structural shift of financial provisions from products that speak to specific needs to solutions that improve the overall financial well-being (Jain et al., 2022). In doing so, customers are five times more likely to purchase additional products and services from a financial provider whom they believe cares about their financial stability (Financial Health Network, 2020). To this end, it is imperative for financial institutions to align their business model to the overarching target of digital financial literacy.

Building on the market-based perspective (Morris et al., 2006) and resource-based perspective (Barney, 1986), a business model determines firm performance by achieving competitive advantages through a firm's strategic market position, the various resources available to the firm, and the firm's ability to use these resources effectively and efficiently (Spiegel et al., 2016). In short, it relates to "the design of organizational structures to enact a commercial opportunity" (George and Bock, 2011). This is particularly relevant for FinTech start-ups, where technological change and initial experience with targeted offerings may require substantial changes to the prevailing business model (Grover and Saeed, 2004).

RESEARCH METHOD AND EXPECTED OUTCOMES

Given the nascent nature of the research context, we have taken a qualitative case study approach to examine an award-winning FinTech start-up that operates across the UK and the EU. The qualitative approach enables us to undertake a deep and exploratory analysis that is essential to develop an understanding towards digital financial literacy in the context of business models. Considering the exploratory nature of the research and the fact that the focal topic being examined is relatively recent, the research calls for the utilization of primary data. As a rapidly growing FinTech start-up has agreed to partake in the project, we will be able to collect data from its co-founders, members of the management board, and employees working at different departments at various organizational levels. We have taken an inclusive approach for the interviewees because it is not uncommon for employees in small businesses, including start-ups, to be actively involved in strategic innovation decisions (Friis and Koch, 2015).

Data from multiple sources, such as semi-structured interviews and organizational documents, will be collected and coded thereafter to facilitate an organized and iterative analysis. We will follow a typical three-stage process of the coding procedure, which includes open coding, axial coding, and selective coding. This is to ensure the analysis of the collected data will be conducted in a systematic manner, which will be conducive to unearthing a number of illuminating academic findings. As a result, we seek to provide an in-depth understanding of digital financial literacy from an organizational perspective through the business model concept (Andrews and Zhu, 2021).

In pursuing this theoretical aim, the project endeavors to expand knowledge on the topic of digital financial literacy and business model for FinTech start-ups and will establish a viable linkage between those two in the context of a thriving digital economy. Practically, this research aims at providing advice to financial providers with regard to their viable strategies for aligning business models with digital financial literacy in a consistent and coherent way. It will also lay out recommendations to policymakers to promote overall digital financial literacy across the population for sustainable financial well-being and overall social development.

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Exploring achievement gamification on online medical quality based on machine learning and empirical analysis

(Work-in-Progress)

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ABSTRACT

How to improve online medical quality is an important challenge for practitioners of digital health platforms. Gamification creates new opportunities to deal with the problem persistent in online health services. To better understand the role of gamification in online health services context, this study intends to use the research method of machine learning and natural experiment to explore the impact of achievement gamification on online medical quality in online health services, as well as the moderating effects of doctors' personality and image. Theoretically, this study will expand the application of game strategy in the field of healthcare, and make up for the deficiency of the effects of gamification on online medical quality. Practically, it provides guidance for promoting doctors' online participation behavior, improves the quality of online health services, and suggests ways for optimizing the rational allocation of online health resources.

Keywords: Digital health, achievement gamification, online medical quality, machine learning and natural experiment.

INTRODUCTION

As a major product in the era of digital economy, digital health has brought subversive changes to health services. It not only facilitates patients' medical treatment, but also enables doctors to obtain more value by providing online services for patients. Furthermore, the emergence of online health services has also promoted the online flow of medical resources. Especially during the period of COVID-19, the popularity of online health services and public awareness have been greatly improved. At the same time, it has also cultivated the habit of people accepting online health services, thus promoting the development of online health services.

Regardless of offline health services or online health services, medical quality has always been the top priority of healthcare services. The medical quality directly affects the health status of patients. However, due to the seriousness and dryness of health services, doctors are often tired of offline health services, and lacked energy for online health services. In addition, it is difficult for doctors to actively participate in online health services because of the uncertainty and unawareness of online health services. This makes online medical quality more difficult to guarantee.

The emergence of gamification provides more possibilities to alleviate the above problems in online health services. As a new concept in recent years, gamification has attracted extensive attention in the fields of education (Santhanam et al., 2016), health (J. Liu et al., 2020; Yang & Li, 2021b), marketing (D. Liu et al., 2017; Tobon et al., 2020) and so on. It is a new way to guide user interaction, increase participation and system interest. Medical gamification refers to the application of gamification elements and mechanisms to scenarios in the healthcare field. The characteristics of game entertainment and immersion make doctors' serious and boring work more interesting, increase the interest of doctors' online services and clarify goals, so as to increase doctors' sense of participation, achievement and value in online health services. This is also a possible solution for doctors who are keen to devote more leisure energy to online health services, and provide higher quality of online services for patients.

Previous studies have explored the impact of gamification on doctors' online participation behavior. Game elements such as badges and ranking are added to the online health services to stimulate the game experience and improve the participation of doctors (J. Liu et al., 2020). At the same time, the online contribution of doctors is stimulated by awarding the title of good doctor of the year. In addition, gamification in online health services introduces competition as a challenge incentive to encourage doctors to actively participate (Harwood & Garry, 2015). However, most of the previous studies explored the impact of gamification on doctors' online participation from the perspective of quantity, while the research on the quality of online participation is insufficient. And gamification is likely to lead doctors to blindly pursue quantity and ignore quality,

resulting in worse online medical quality. Achievement gamification design increases the sense of achievement after doctors' efforts. Will this promote doctors to provide higher quality online health services? These mechanisms are unclear and lack of effective causal evidence. Therefore, this study explores the impact of achievement gamification on online medical quality.

Medical quality includes both medical technology quality and medical service quality. Previous studies mostly measure medical quality from the perspective of patients. For example, patients' satisfaction with doctors' service quality and service attitude, and few studies explore medical quality by mining doctors' own generated information from the perspective of doctors. Therefore, this study will use supervised machine learning method to extract medical technology support and medical service support from the text information generated by doctors' online services for patients, and use these two variables to measure medical technology quality and medical service quality, respectively.

Therefore, based on the above discussion, this study raises the following research questions: how does achievement gamification affect online medical quality (medical technology quality and medical service quality) provided by doctors to patients? In addition, the medical technology quality and medical service quality provided by doctors may be related to their own characteristics. Therefore, the second research question is raised: is the moderator role of doctors' personality traits and doctors' image?

THEORETICAL BACKGROUND AND HYPOTHESES

Gamification on the Online Health Services

In recent years, gamification has gradually penetrated into the field of healthcare. Gamification is not only a method, but also a way of thinking. The essence of gamification is to use game-thinking to solve non-game problems, users can experience the feeling of game and immerse themselves in the experience of gamification, so as to encourage users to actively participate in behavior and motivation. The gamification design in online health services aims to stimulate the game experience and improve doctors' participation by adding game elements to the environment (Yin et al., 2022). It can make doctors actively participate in online health services by adding badges and ranking, which is obvious to other doctors and patients (Liu et al., 2011). At the same time, giving doctors the title of good doctor of the year can reflect their professional knowledge and contribution in the past, which provides a basis for patients to evaluate the credibility of doctors and the reliability of their treatment before choosing online health services. In addition, gamification in online health services introduces competition as a challenge and incentive to encourage doctors to actively participate (Harwood & Garry, 2015). According to the motivation theory of gamification mechanism, excepting intrinsic motivation, extrinsic motivation such as economic return is also an important motivation, which may increase doctors' participation in online health services (Zhou et al., 2019). The achievement gamification design in online health services increases the participation of doctors and makes them keen to compete with others in the process of online services (Liu et al., 2011). The result of this competition among doctors makes the economic returns unequal. The basic principle is that the economic return obtained by doctors from online health services mainly comes from the consulting fees paid by patients, and the level of economic return is positively affected by the number of patients (Guo et al., 2017). Therefore, in online health services, gamification is also closely related to the financial return of doctors.

Gamification in patient health management is considered to be an effective solution that can change health behavior and improve health management performance (Wouters et al., 2013; Sardi et al., 2017; Sola et al., 2015). Gamification can effectively promote individuals' enjoyment of health management and meet their internal needs for health management (Sailer et al., 2017). The main manifestations are as follows: ① Gamification improves the performance ability of individual health management. For example, Allam et al. found that gamification-intervention has a positive impact on patients with rheumatoid arthritis and effectively improves the health management performance of patients with chronic diseases (Allam et al., 2015). ② Gamification promotes changes in personal health behavior. Hamari compared the impact of game design and non-game design on individual physical activities (Hamari, 2017). ③ Gamification increases the willingness of individuals to continuously use health information technology. Yang et al. found that gamification-intervention can improve individuals' perceived usefulness of mHealth, promote their willingness to use mHealth and increase their frequency of use (Yang & Li, 2021b).

Achievement Gamification on Online Medical Quality

The online medical quality is an important part of online health services, which directly affects patient satisfaction, diagnosis and treatment effect, health status and so on (Chen et al., 2020). According to 3Q service quality theory, the online medical quality could be divided into technology quality, system quality and service quality (Xu et al., 2013). Prior literature illustrated that service quality at different stages is an important driver of patient compliments (Wu et al., 2020). Yan et al. posited that the information and emotional are the major type of social support that patients can exchange in online patient-patient interactions, furthermore the companionship support has a positive impact on the peer-patient health status (Yan & Tan, 2014). Mein Goh J et al. (Goh et al., 2016) also confirmed that patients living in rural areas can obtain more benefits by exchanging information with the outside world through the online health services, helping to alleviate regional health disparities between rural and urban users. Therefore, in the online doctor-patient health services, online technology quality and service quality are the major types of online medical quality that doctors and patients exchange in their online interactions.

In previous studies, many scholars have studied the external factors affecting doctors' online service quality from the perspective of motivation theory, including patients' active participation (Chen et al., 2020), the number of patients' gifts (Zhao et al., 2017), thank-you letters and so on (Wiering et al., 2017; X. Zhang et al., 2020). While it also remains unclear what are the internal factors for doctors to provide online health service. Liu et al. (X. Liu et al., 2016) have shown that doctors' online reputation and offline reputation are important determinants affecting doctors' performance. The achievement elements in gamification could make users get more sense of achievement and satisfaction (Xi & Hamari, 2019; Yin et al., 2022). Therefore, we infer that achievement gamification could promote the doctor to provide higher quality of online service. Thus, we hypothesize that:

H1: Achievement gamification has a positive effect on online medical quality (H1a: medical technology quality, H1b: medical service quality).

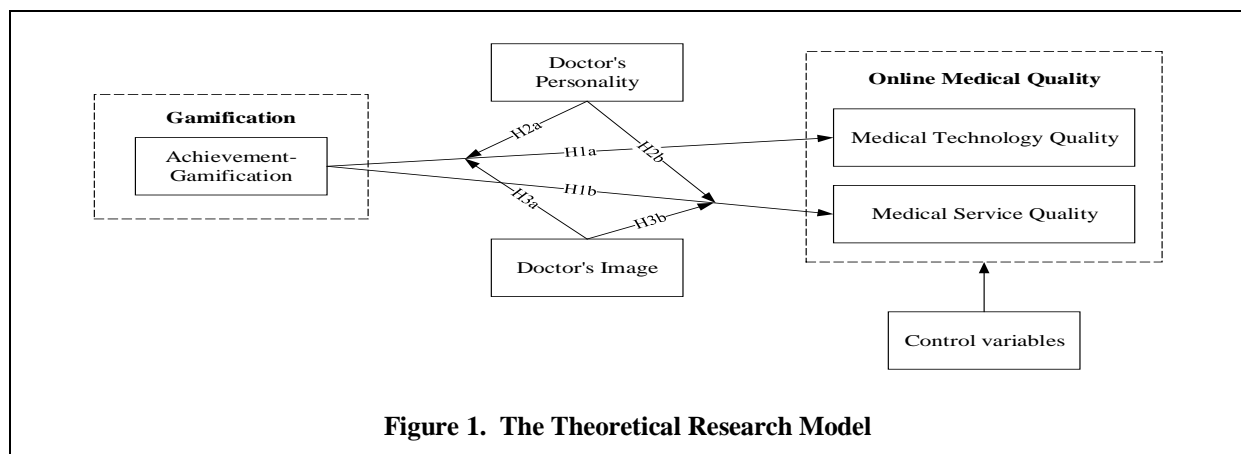
Moderating Effects of Doctors' Personality and Images

Beyond that, the service quality theory indicates that in different situations, individuals have different expectations in the process of services. Specifically, some scholars have shown that users with different personality traits have different levels of sensitivity to their own behavior (Bansal et al., 2010). Doctors' external behavior stems from their real internal personality. With that in mind, we posit that a doctor's online performance is the true reflection of their internal personality. Thus, it is worth to explore the moderator effect of doctors' personality. Hence, we hypothesize that:

H2: Doctor's personality has a moderator effect on between achievement gamification and online medical quality (H2a: medical technology quality, H2b: medical service quality).

Furthermore, the doctor's images, similar to a brand image, is also a symbol of a person's status or reputation. Prior study has indicated the brand image increases trust and purchase intention, the brand image may moderate the potential negative effects of that text length on trust and purchase intent (Agmeka et al., 2019). And in the field of sharing economy, the Airbnb property demand changed after the acquisition of verified images, properties with verified images had 8.98% higher occupancy than properties without verified images (S. Zhang et al., 2021). On this basis, it can be inferred that doctors with high-quality doctor image are willing to pay more efforts than those with low-quality doctor image. Thus, we also assume:

H3: Doctor's image has a moderator effect on between achievement gamification and online medical quality (H3a: medical technology quality, H3b: medical service quality).



RESEARCH METHODOLOGY

Research Context

Our study focuses on the online health community: haodf.com, which comprises the greatest quantity and quality of authoritative doctors in China. The haodf.com portal was founded in 2006 and is a leading Internet medical platform in China. In fact, haodf.com includes about 790,000 physicians from more than 10,000 different hospitals in large cities providing online appointments and patient management services. It not only generates a large number of structured data, unstructured text and image data, but also provides a game design environment, which provides a good research context for this study. The research context is shown in Figure 2.



Figure 2. The Research Context

Study measures

The dataset will be selected through a python crawler to collect historical data for doctors and their attributed data from Haodf.com with a monthly panel dataset. The definitions and descriptions of the major variables are provided in Table 1.

Table 1. The Description of Variables

Variables	Definition & Measure
Dependent Variable	
<i>Achievement Gamification</i>	A dummy variable indicating whether the doctor have obtained achievement gamification. 1 represents that the doctor has obtained achievement gamification; 0 represents that the doctor did not obtain achievement gamification
Independent Variable (Online Medical Quality)	
<i>Medical Technology Quality</i>	In the process of online health services, the average value of doctors providing help to patients from professional and technical aspects in a month
<i>Medical Service Quality</i>	In the process of online health services, the average value of doctors providing help to patients from the aspects of humanistic care such as emotion and attitude in a month
Moderate Variable	
<i>Doctor's Personality</i>	The scores of the openness, conscientiousness, extroversion, agreeableness and neuroticism personality trait of a doctor. The value is in the range of 0-100
<i>Doctor's Image</i>	The doctor's image information classification. 1 for positive emotion; 0 is neutral or negative emotion
Control Variable	
<i>LogTotalPatients</i>	The number of online patients in a month
<i>RecomHeat</i>	Online recommendations from patients. The value is in the range of 3-5
<i>LogThanksLetter</i>	The number of online letters from patients in a month
<i>LogGiftNum</i>	The number of online gifts from patients in a month
<i>LogTotalPapers</i>	The number of online papers that doctors have published in a month
<i>LogPatVotes</i>	The number of online votes from patients in a month

Research Procedures

This study is expected to use machine learning and natural experiment methods to verify the research hypotheses. Machine learning method mainly extracts the required dependent variables and moderator variables from unstructured text data and image data. The natural experiment method is to verify the causal effect of achievement gamification on online medical quality (medical technology quality and medical service quality).

① Machine learning process

The machine learning process includes three parts: First, extracting online medical quality (medical technology quality and medical service quality) from the text information of online doctor-patient interaction by using supervised machine learning method. Second, classifying doctors from their images by image recognition. Thirdly, based on the doctor's multidimensional data, the unsupervised text analysis method is used to extract the doctor's personality trait. The process of machine learning process includes data collection, data pre-processing, database, variables extracting (supervised machine learning, unsupervised text mining, image recognition), then the dependent variables and moderator variables of this study are obtained.

② Natural experiment design

Natural experiment design is mainly through the game design of online health platform to form a natural experiment. The treatment group is the doctors who get the achievement gamification, the doctors who did not obtain the achievement gamification were taken as the control group (Table 2). In the process of doctors and patients participating in online health services, a large number of observable structured data and unstructured text or picture data are generated. By compiling Python web crawler, this study obtains the panel data generated by doctors in online health services, and uses natural experimental

methods to explore the causal effect of achievement gamification on online medical quality (medical technology quality and medical service quality). In particular, whether individual doctors participate in gamification is affected by their own characteristics (such as personality traits or image), and in order to make the research results closer to the causal effect, need to be eliminated the endogenous and selective bias. Therefore, this study will use PSM method to match the samples, and then use DID to analyze the causal effect of gamification. The equations are presented as follows.

Table 2. The Nature Experiment Design

	Before	After
Treatment Group	O	X
Control Group	O	O

The causal effect model of achievement gamification on online medical quality (medical technology quality and medical service quality) is as follows:

$$OnlineMedicalQuality_{it} = \beta_0 + \beta_1 Gamification_{it} + \beta_2 A_i + \beta_3 B_t + \varepsilon_{it}$$

The moderator effect model of doctors' personality and image is as follows:

$$OnlineMedicalQuality_{it} = \beta_0 + \beta_1 Gamification_{it} + \beta_2 Gamification_{it} * Personality_i + \beta_3 Gamification_{it} * Image_i + \beta_4 A_i + \beta_5 B_t + \varepsilon_{it}$$

Where, i represents a doctor, and $OnlineMedicalQuality_{it}$ represents to online medical quality (medical technology quality and medical service quality); $Gamification_{it}$ is a dummy variable of the experimental group, and the control group was the baseline; $Personality_i$ is the individual personality trait of doctor i ; $Image_i$ is the doctor's image information, and A_i represents the individual fixed effect; B_t represents time fixed effect; ε_{it} is a random error term.

CONCLUSIONS AND OUTLOOK

This study expects to verify the causal effect of achievement gamification on online medical quality (medical technology quality and medical service quality) through machine learning and natural experiment based on service quality theory. Theoretically, the research results will expand the application of game strategy in the field of healthcare, furthermore, it makes up for the deficiency of the gamification on online medical quality from the theoretical level. Meanwhile, it would provide theoretical guidance for improving the medical game design system. Practically, it provides theoretical and practical guidance for medical platform managers to design reasonable game strategies to promote the effective operation of online health services. Furthermore, for patients, it can also increase the good medical experience of patients and help patients' online decision-making behavior.

While the conceptual model of this study is grounded in empirical work and literature, it is still in its infancy. The follow-up work of the conceptual model will include an extended literature review to improve the understanding of each hypothesis. Further work will also include more detailed presentations of the methodology, empirical analysis and discussions introduced in this paper. Finally, in the robustness test section, this study will eliminate the endogenous problem of whether doctors choose gamification through the method of instrumental variables. As a prospect of this study, it can be concluded that the further potential of this study lies in extending the research model to include grouping experiments. Furthermore, it is important to consider the different sub-dimensions of gamification design in this study. Further to this, it is also important to consider the impact of multi-gamification integration strategies on the comprehensive benefits and heterogeneity, such as achievement, immersion and sociality elements.

ACKNOWLEDGMENT

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Fur babies, governance, and ability: Finding meaning in survey response rates

(Work-in-Progress)

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ABSTRACT

We demonstrate that the use of visual cues in reminder emails can elicit increased response rates. Survey demographics and response rates were drawn from an ongoing survey being conducted within a not-for-profit organisation in Australia. The use of animals (“fur babies”) has an impact on the younger and older demographics and those without a university education. These ages and educationally limited cohorts are often seen as problematic to motivate to engage with surveys. For this study, the optimal time to elicit most responses was 12 weeks.

Keywords: Demographic, survey reminder, survey period, visual cues.

INTRODUCTION

Conducting surveys and obtaining response rates that allow for meaningful conclusions to be drawn is challenging. It is well-documented in the literature, that increased survey response rates were tied to follow-ups and repeated contacts (Yammarino *et al.*, 1991; van Mol, 2017). Importantly, it is not uncommon for web-based surveys to have response rates well below 20%, with many researchers reporting rates of 10% or lower as meaningful to use to develop policy and inform planning decisions (van Mol, 2017). Furthermore, the reliability of surveys is often an issue as they have an innate bias with respondents seeking to report acceptable attitudes and behaviours (Singh and Tir, 2021; Butler *et al.*, 2022). There are three factors that have been identified to be directly linked to survey response rates: the level of workplace deviance; the cognitive ability of the staff; and the employees self perceives socioeconomic status (Lallukka *et al.*, 2020; Jenkins *et al.*, 2021; de New & Schurer, 2022).

Institutional responses to online surveys can provide insights into the governance behaviour within an origination. Those who fail to complete workplace surveys were found to have higher rates of workplace deviance (Jenkins *et al.*, 2021). Those who do respond to a survey and are Organisational compliance and conflict-averse, are also more likely to respond in ways that they perceive the organisation’s desires leading to distorted results (Singh and Tir, 2021). Cognitive dissonance theory postulates that a more compliant employee is likely to undertake actions that reduce conflict and have a belief that is easier to comply and fill out the survey, in contrast to those who do not fill out the survey and weigh the risk of consequences for non-compliance, and in the case of voluntary surveys with no consequence for failing to comply, therefore ignore it (Jenkins *et al.*, 2021). Thus, low rates of reply implicitly imply that the respondents are the more compliant employees and omit disruptors, and this compliant demographic is likely to generate a bias in terms of perceived Organisational desired responses. Importantly, non-compliance in surveys may indicate that there are underlying governance issues at play, and this can lead to direct costs to the organisation in form of reputational damage, loss of business, and regulatory action.

Recent studies indicate the use of surveys as a means of measuring cognitive ability. In particular, the performance of a task, such as the effective completion of a survey, can be used to indicate an individual’s personal ability and other skills with high achievers more likely to respond (Adams & Umbach, 2012; Kautz *et al.*, 2014; de New & Schurer, 2022). Diligence and willingness to cooperate in a survey are correlated with conscientiousness emotional stability and openness to experience, and non-compliance is often a marker of noncognitive ability (Hu, 2020; de New & Schurer, 2022). This can be narrowed down to three measures of cognitive ability to backward digital span, symbol-digit modalities, and national adult reading test (de New & Schurer, 2022). Surveys have a role in informing on the level of corporate ability, with higher compliance and survey completion rates indicative of a more cognitively able workplace.

Social class, measured in terms of socioeconomic position and health, indicates that there is a lower response rate to surveys from those who self-identify as socio-economically challenged (Lallukka *et al.*, 2020). This can be linked to the form of

employment and the relationship with an organisation that an individual has at the time of the survey, with higher responses from full-time and those with reduced absenteeism (Lallukka et al., 2020). Therefore, survey response rates may indicate a snapshot of employees' self-perceived health and welfare.

There have been limited studies into the use of visual cues to elicit higher response rates to surveys. In advertising, offering food cue images to the obese and others with eating disorders stimulus increased interest within those demographics to the subject matter being presented (Castellanos et al., 2009). However, little is known about the effects of visual cues to elicit an increase in survey response rates. This study examines the internal survey response rates in a not-for-profit organisation. In particular response rates to changing reminder formats and visual stimuli are graphically reported. Furthermore, response timing is matched with demographic information on age and education level.

METHODS

The data used in this paper was drawn from a broader survey with participants from a not-for-profit organisation in Australia (Ethics Number - H8726). This paper deals with the first 15 weeks of the survey; however, at the time of writing the survey remains ongoing, and the wording of the email subject changed with each reminder. In seeking to elicit increased survey response numbers, a weekly email was sent to remind the participants and to highlight the importance of their contribution. As part of this reminder process, visual cues were included to attract the attention of potential respondents. Visual cues are classified into three categories: 1) slide – colourful with keywords; 2) video – a video of the primary researcher explaining the importance of the project; 3) images – images of the primary researcher's pet dogs, referred to in the remainder as “fur babies”. A total of 119 responses were received after the 15-week period. A total of 98 valid responses for age and education were received, although not all respondents answered both questions. Responses were charted by age and educational attainment.

RESULTS AND DISCUSSION

The data indicate that the use of visual cues in emails elicits an increase in the rate of response to the survey (Figure 1). By week 12, the response rate was near zero, indicating in this case that 12 weeks is the optimal survey period (Figure 1). Soliciting and recontacting in increased response rates are highly dependent on the subject lines in the emails that are being sent (Liu, 2020). Using words that imply the importance of the necessity to respond has higher rates of engagement than passive subject lines (Cuciniello, 2013). In this study change in subject only had a marked effect on response rates when the term “CEO” was included, this term builds familiarity with the sender and simplicity increases the perceived importance of the survey and triggers increased rates from those less compliant employees. All other subject lines included a combination of the keywords “HR” + “PhD” + “your opinion” and these did not generate an increase in response rates. It can be argued that to engage with fewer complaint resonances the subject needs to reflect a level of authoritativeness, in this case from the CEO. This authoritativeness implies the importance to the survey and an implicit increased risk as a consequence of failing to comply (Jenkins et al., 2021).

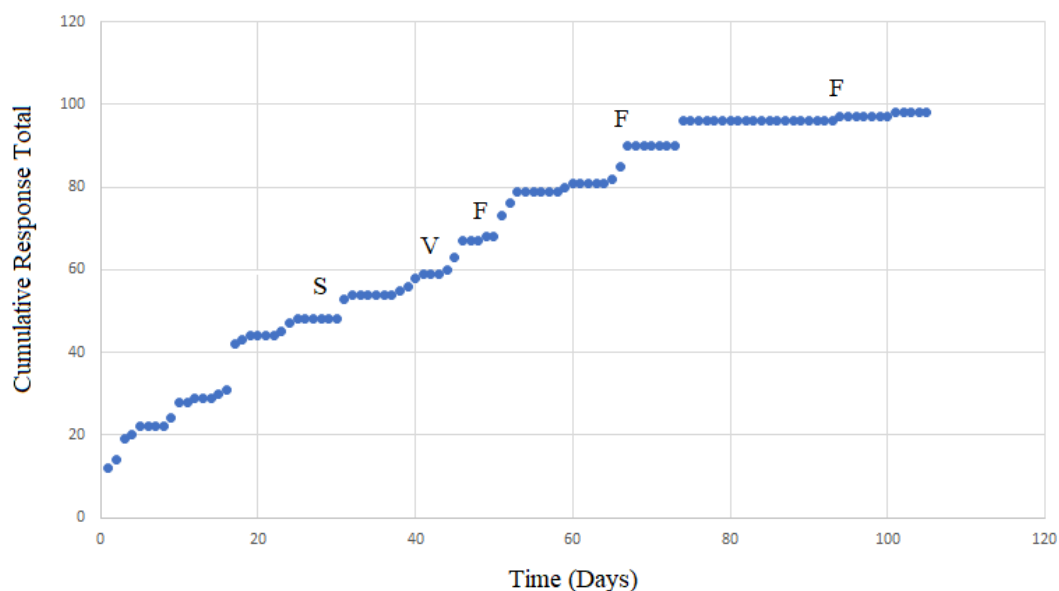


Figure 1: The daily cumulative survey response totals showing the time of stimuli (S = slide; V = video; F = animals) and the corresponding jump in response number. The first spike (~ week 3) corresponds to a subject change to the email to include the “CEO- HR survey, the second spike in week 11 reflects the engagement of a cohort of staff that has been on leave.

While the slide and video had some marked effect on the rate, the images of the animals lead to a sharp rise in responses. In particular, the use of animals engaged the 18-24, 25-34, 55-64 and 65-74 age cohorts, these groups had shown no responses in the prior three weeks to the animal cues (Figure 2). The 35-44 and 45-54 showed a steady engagement with the survey (Figure 2). The use of animal visual cues also led to an increase in the response rates from individuals who did not have university qualifications (Figure 2). Reduced rates of response from younger and less educated staff may reflect on their level of

engagement within the workplace with studies indicating that workplace response rates are linked to workplace satisfaction (Mueller et al., 2011). These cohorts tend to earn less and therefore see themselves as socio-economically challenged, a fact known to reduce survey response rates (Lallukka et al., 2020). The use of familiar cues, in this case, animals, generates a feeling of familiarity and this led to increased engagement reflected in the survey response rates after those cues in those demographics (Miller et al., 2021).

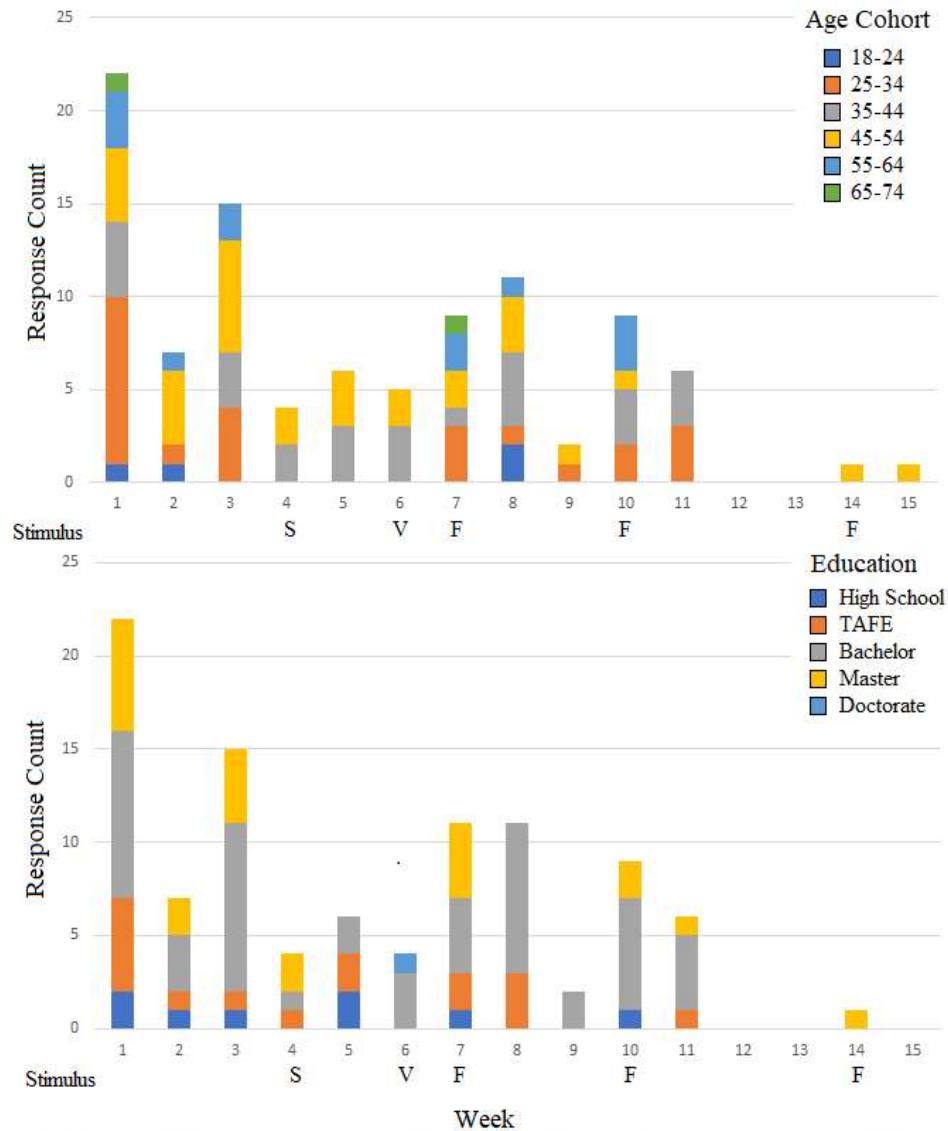


Figure 2: The weekly survey response rate by age and education demographic cohorts showing the extra stimuli (S = slide; V = video; F = animals) used as an inclusion in the weekly reminder notice to elicit responses. Images of the animal stimuli are shown. The disparity in the number of responses between the two cohorts reflects missing response data to the survey question.

CONCLUSION

The use of emotive imagery and reminders was shown to increase response rates to an organisational survey. Response rates not only enhance the validity of a survey, but also indicate the workplace deviance demographic, with higher response rates indicative of more compliance and functional ability within workplaces. Further research is needed in understanding the link between organisational survey response rates and the level of ability, governance, and compliance within an organisation. If this link can be established, then running simple surveys across a workforce will provide insight into the potential for cultural and deviance issues that may lie hidden within the workforce.

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Gerontechnology acceptance of smart homes: A systematic review and meta-analysis (*Work-in-Progress*)

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ABSTRACT

Advances in preventive medicine and technology have beneficially affected longevity in the past decades. Unfortunately, longer life expectancy and declining fertility are likely to trigger an increasingly aging population, posing new challenges for social systems. Since aging populations affect the healthcare industry, providing convenient solutions and user-friendly elderly healthcare services is necessary to curb the growing demand by older adults. Several studies have proposed intelligent homes as potential solutions to support old age. However, such solutions raise the question of whether or not elderly persons intend to use smart homes and benefit from them. This paper examines the gerontechnology acceptance of intelligent homes by systematically reviewing previous studies on older people's intention to use innovative home technology. The review was conducted from the Web of Science, Google Scholar, and Scopus, retrieving a thousand articles. Out of these, 40 are selected for the meta-analysis and systematic review. The integrative results showed an increasing intention of older adults to use smart home technology as they believe those innovative ways may improve independent living. However, attributes and drivers like privacy and perceived security show increasing heterogeneity and should draw more attention to prospective researchers.

Keywords: Gerontechnology; older adults; smart home; technology acceptance.

INTRODUCTION

The increase in longevity, the growing number of older adults, and the decreasing number of newborns denote that most countries' populations are aging rapidly (Lamnisos et al., 2021). The increase in the proportion of older people is mainly due to changes in health indicators, including improved nutrition and hygiene (Mehri et al., 2020). Additionally, advances in preventive and curative medicine have enabled many (older) patients to survive life-threatening medical conditions. Unfortunately, this does not mean that all seniors are healthy and well.

To anticipate the growing demand for health care by older adults, governments and policymakers are trying to empower older persons to maintain independence for as long as possible. By enabling them to keep residing in their own homes, i.e., to age in place, costly options such as nursing homes can be avoided. Smart homes have been postulated as a potential solution to support aging in areas. A smart home is a residence equipped with a high-tech network, linking sensors and domestic devices, appliances, and features that can be remotely monitored, accessed, or controlled and provide services that respond to the needs of its inhabitants (Robles & Kim, 2010). Several target groups could benefit from innovative home technology, including older adults who would like to age in place. Furthermore, smart home technology can assist in monitoring and maintaining health status.

Previous studies emphasize intelligent homes, but their existence is not widespread. Consequently, their suggested potential for older adults in promoting independence and aging in place, alleviating pressure on (family) caregivers, and decreasing health care expenditure, has not yet reached its full potential. The question remains why smart home technologies are not yet commonplace in the homes of older people. The present study aims to answer this question by examining and discussing older people's views on independence and intelligent home technology. We will discuss older people's perspectives on aging in place and remaining independent. The remainder of this paper is organized as follows—section 2 describes materials and methods, including search parameters and databases. Section 3 is dedicated to results and discussions.

MATERIALS AND METHODS

Search strategy

This research systematically reviews previous academic works on gerontechnology acceptance of smart homes. The review was conducted by following the reporting checklist of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method (Johnson & Hennessy, 2019). This study's comprehensive literature search was undertaken online through Web of Science, Scopus, and Google Scholar databases on August 10, 2022. The searching items consist of "gerontology" OR "elderly" OR "seniors" OR "old age" AND "smart home" OR "home automation" OR "domotique" OR "intelligent home" OR "adaptive home" OR "aware house." We also sought eligible articles according to the reference list of potentially eligible studies. One thousand articles were identified and sorted by "Relevance" from 1996 to 2022. Of these, 40 relevant academic works concerning technology acceptance of smart homes among older adults were studied.

Inclusion and exclusion criteria

Studies were included if the object of each study was technology acceptance and adoption by older adults. Any study matching any of the following criteria was excluded.

- i: the study was not about technology acceptance among elderly people
- ii: case report, comment, conference abstract, design research, letter, review
- iii: articles that are not written in English
- iv: insufficient data or no available data, or inconclusive results

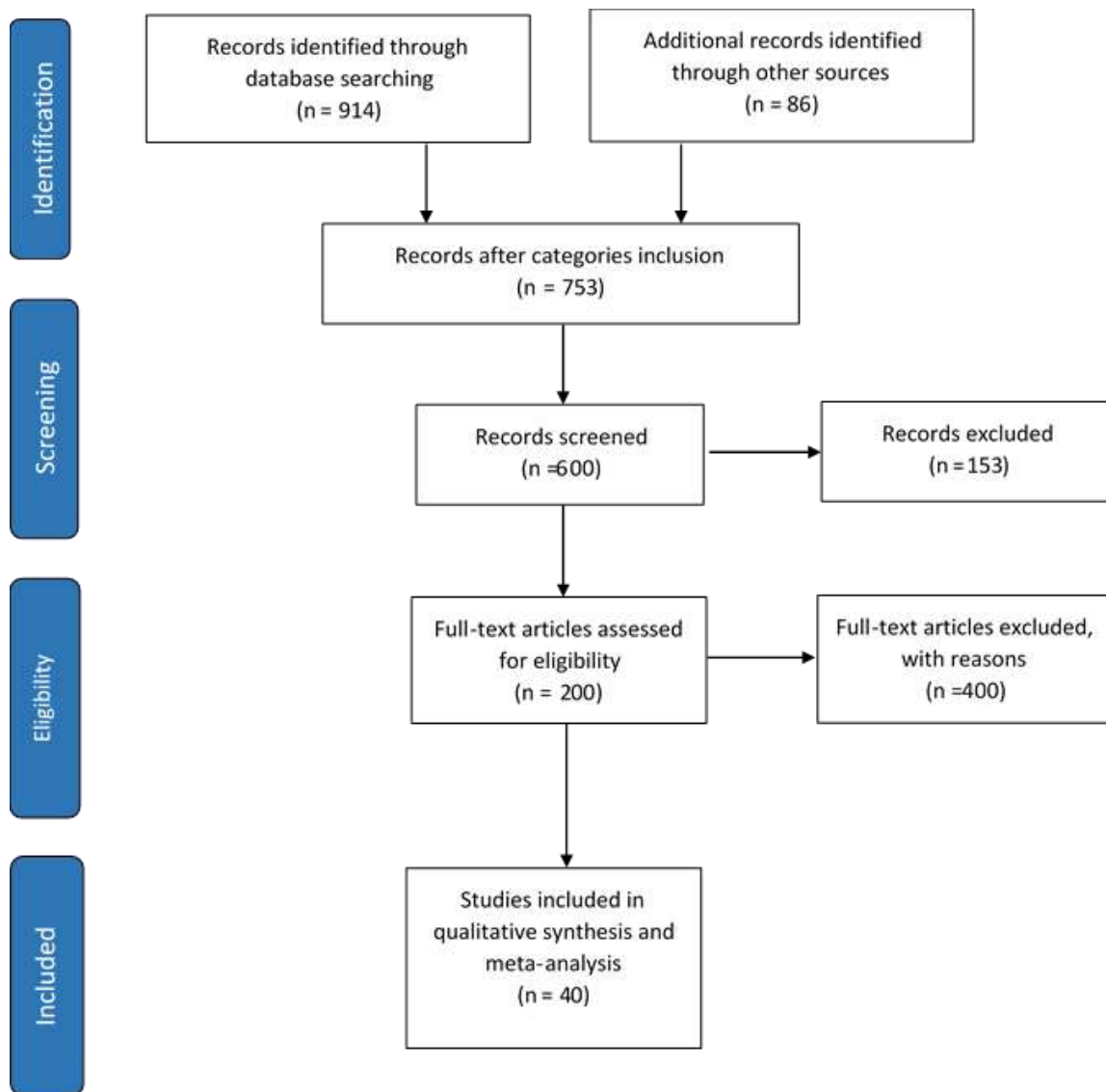


Figure 1: Literature searching following the PRISMA methodology

Quality assessment and statistical analysis

We apply Review Manager 5.4 to evaluate each study's quality and make the meta-analysis's outcomes robust. Through “yes,” “unclear,” or “no,” we apply a risk of bias approach for the included studies, as shown in Fig. 2. Then, the combined data was further analyzed in the forest plots. Each continuous outcome was expressed by weight mean difference and 95% confidence interval. The Inconsistency index was implemented to measure the heterogeneity of all included studies using a random-effects model. Statistical significance was defined by a p-value less than 5% ($p < 0.05$).

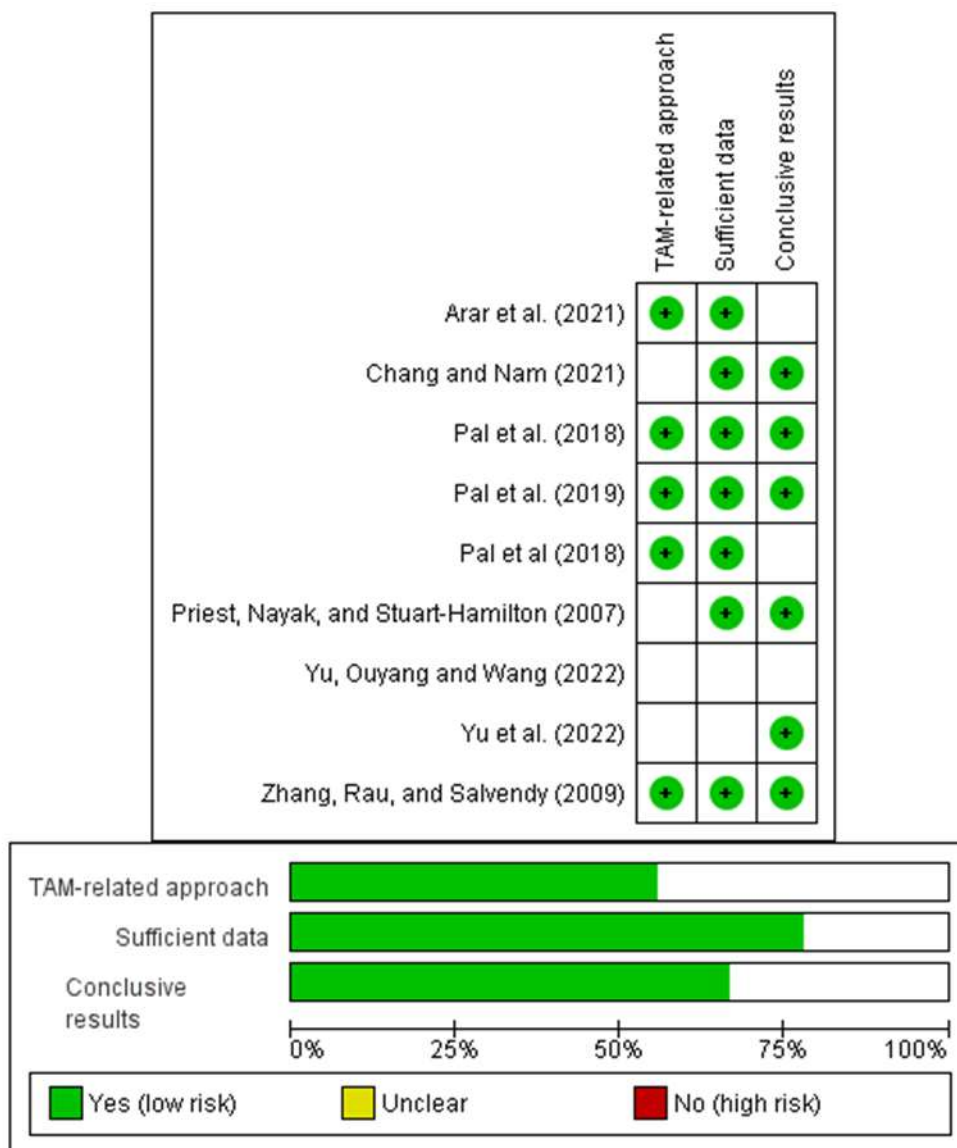


Figure 2: Risk of bias summary

RESULTS AND DISCUSSIONS

Smart home developments and potential benefits for older adults

Many developments are taking place in the field of smart home technology, and expectations are high regarding the potential benefits for the elderly (Barlow & Venables, 2004; Hu et al., 2020). Previous studies have developed new technologies and methodologies to improve older adults' independence and prevent health events (Cho & Kim, 2014; Mihailidis et al., 2004; Ocepek et al., 2013; Ravishankar et al., 2015). These studies showed that home automation's use among older adults positively relates to outcomes such as cognitive status and improved social. The other included studies did not demonstrate strong evidence of support for aging in place, mainly due to their study designs and methodologies.

Our analysis showed that most research on community-dwelling older adults study the elderly's perception of a technology that has not been used yet (Agarwal et al., 2016; Wong & Leung, 2016). These studies typically refer to this stage as the pre-implementation stage and include presentations, prototypes, or scenarios to explain or demonstrate the technology to participants (Ehrenhard et al., 2014; Onibonoje et al., 2016; Yu et al., 2015). Consequently, older adults are asked about a technology they have not used and experienced for a considerable time. They, therefore, raise concerns regarding such technology when benefits have not been demonstrated clearly in terms of scientific evidence. Those concerns are primarily related to drivers, such as usability, cost-effectiveness, behavioral change, showiness, and impracticality. That implies that using home automation technologies may be burdensome. (Gao et al., 2018; Kim et al., 2017; Lago et al., 2019).

However, despite rising concerns, older adult users may also expect benefits, such as increased safety and independence (Ahmad et al., 2016; Jung, 2017; Monteriù et al., 2018). But, it is worth noting that these perceived benefits do not "automatically" translate into accepting adaptive home technologies, as illustrated by Shuhaiber and Mashal (2019). Many older adults may believe that innovative home technology can contribute to independent living, yet these conditions often do

not lead to a willingness to accept intelligent home technology. However, studies such as Arar et al. (2021) found that age group and computer technology affinity are the most influential variables and elderly users have anxiety about technology, which influenced the acceptance of innovative home technology. (Fig. 3). The following paragraph will look more closely at older adults' concept of independence and its relation to their perceptions and acceptance of smart home technology.

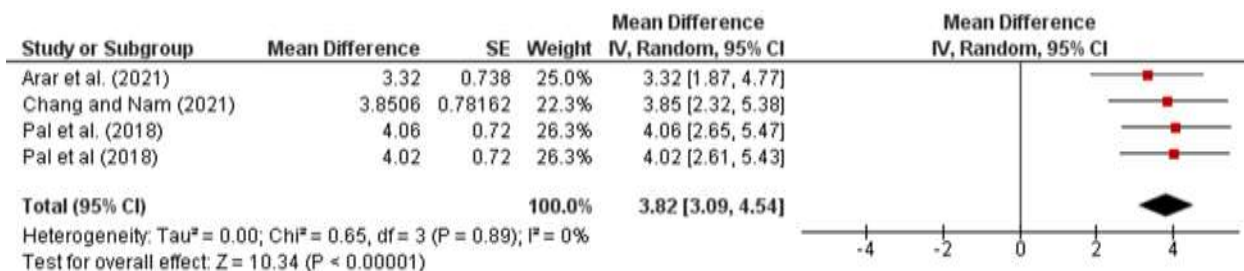


Figure 3: Intention to Use

Independence and its relations to the acceptance of technology

Independence is referred to the ability to live without relying on external help or not feeling obligated to someone (Plath, 2008). Privacy issues are an example of how independence perception can influence the acceptance of smart home technology. Fig. 4 depicts Studies in which community-dwelling older persons can see technologies that enable sharing personal information with formal and informal caregivers as something that allows them to stay in their current dwelling (Arar et al., 2021; Pal et al., 2019; Pal, Triyason, et al., 2018). In other words, they perceive that technology can favor the ability to look after oneself. This outlines that intelligent home technology can positively and negatively influence the feeling of being obligated to someone.

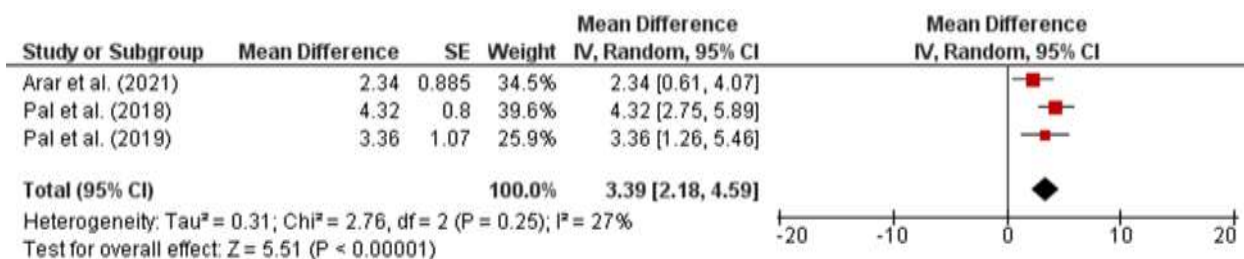


Figure 4: Perceived Security and Privacy

The examples mentioned in this paragraph show that many older people's perceived positive and negative consequences of using technology in the context of aging in place can be defined in terms of the impact of technology on their perceived independence.

Determinants of home automation services for elderly people

The potential intelligent home services market is still in its early stages. As such, existing research has primarily focused on the determinants of its adoption. Based on a value network analysis of a Dutch smart home implementation case, Ehrenhard et al. (2014) identified several factors that impact the adoption of IoT intelligent home services. They confirm that successful market adoption of multi-stakeholder technology like smart homes is low and low adoption is due to the complexity of the surrounding business ecosystem.

Our review also indicates that studies mainly extend the Technology Acceptance Model (TAM) to scrutinize factors impacting the adoption of innovative home technology or services by the elderly (Table 1). For example, Pal et al. (2021) extend the technology acceptance model with three additional factors: compatibility, perceived complementarity, and privacy concerns. They found that usefulness, ease of use, compatibility, and perceived complementarity significantly and positively affect behavioral intention. Similarly, Etemad-Sajadi and Dos Santos (2019) integrated several latent variables, such as social presence, trust, and degree of intrusiveness, into the TAM. Their findings show that trust in these technologies significantly impacts the perception of usefulness and the degree of intrusiveness.

However, previous studies have widely criticized the TAM and proposed several revisions and theories to address its limitations (Arthanat et al., 2020; Opoku & Francis, 2019). For instance, Sequeiros et al. (2021) employ the unified theory of acceptance and use of technology 2 (UTAUT 2) to evaluate the impact of smart home usage on well-being. They found that hedonic motivation associated with adopting some intelligent home services moderates continuing use, suggesting a positive relationship between the use of IoT innovative home services and well-being. Those insights align with the findings from Jiang et al. (2021), proposing a stimuli-Organism-Response (S-O-R) model to investigate the direct influence of trust and self-efficacy on well-being and learning performance and the mediating role played by these variables. The results show that intelligent technologies can affect learning performance through self-efficacy and well-being. Other research has also

demonstrated the well-being benefits of intelligent homes, assigning greater importance to services within the lifestyle support category, such as e-health, assisted living, entertainment, convenience, and comfort (Hersh, 2015; Pirzada et al., 2022).

Table 1: Summary of gerontechnology acceptance models included in this review

Framework	Drivers	Smart home technology/feature	Studies
Technology Acceptance Model	Perceived usefulness; perceived ease of use; attitude; behavioral intention; Social presence; Degree of intrusiveness	Intercom systems; motorized shutters; smart lighting bulbs; smart speakers; intelligent smoke detectors	Peek et al. (2016); Pal, Triyason, et al. (2018); Pal, Funilkul, et al. (2018); Etemad-Sajadi and Dos Santos (2019); Pal et al. (2021); Arar et al. (2021); Pirzada et al. (2022); Hubert et al. (2018); Nikou (2019); Gaul and Ziefle (2009); Al-Husamiyah and Al-Bashayreh (2022); Mashal et al. (2020); Pal et al. (2019)
Unified Theory of Acceptance and Use of Technology	Technology anxiety; Effort expectancy; Facilitating conditions; Social influence; Hedonic motivation; Well-being	Assistive robot; e-health; assisted living;	Arthanat et al. (2020); Sequeiros et al. (2021); Pirzada et al. (2022); Hersh (2015)
Technology to Performance Chain Model	Perceived need; Appearance; Perceived usefulness; Perceived stigma	Legged Robots; Robotic Wheelchairs;	Kencebay (2019); Hersh (2015);
Theory of Planned Behavior	Mobility; privacy risk; trust;	N/A	Watfa and Akili (2021); Yang et al. (2017); Zhang and Liu (2022); Chang and Nam (2021)
Task Technology Fit model	Perceived task technology fit; Perceived usefulness; Perceived ease	N/A	Marikyan et al. (2021) ; Marikyan et al. (2019) ;
Skill-Rule-Knowledge model	Cognitive mode; Skill-based tasks; Rule-based tasks; Knowledge-based tasks; Task Accuracy Rate	Button Size; Icon Style	Zhang et al. (2009); Yu, Ouyang, Wang, et al. (2022); Yu, Ouyang and Wang (2022); Priest et al. (2007)

Other results pinpoint the cognitive ability and performance across different generations (Fig. 5). For instance, Priest et al. (2007) scrutinized the influences of fluid intelligence and website experience on a website task by 99 community-dwelling older adults. Their results show that task performance was not significantly influenced by fluid intelligence score or age, but there was a significant influence by prior website experience. In contrast, Yu, Ouyang and Wang (2022) show that the results and performance of the older group were consistent, while the younger group had no significant difference in sliding orientation and track color.

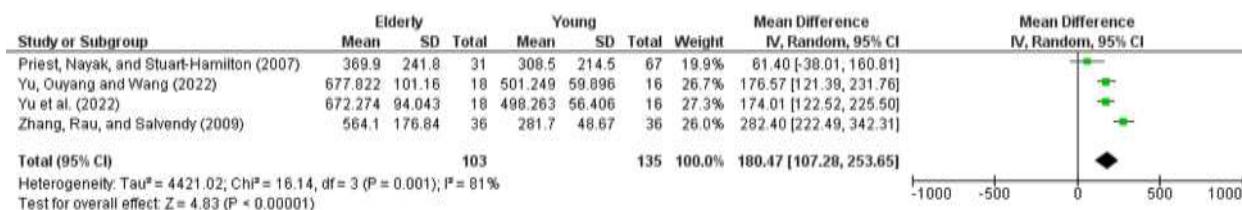


Figure 5: Cognitive ability and performance

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Modelling the mitigation of the negative effects on human resource management

(Work-in-Progress)

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ABSTRACT

Human resource professionals are often overlooked in the study of frontline workers and the negative effects of burnout, compassion fatigue, stress and vicarious trauma even though exposure to these negative workplace conditions is intrinsic to their job description. Understanding how these negative workplace conditions affect human resources professionals will lead to reduced employee absenteeism and higher staff turnover and mitigate the effects of presenteeism, such as reduced productivity and loss of general work satisfaction. In this paper, the literature is explored to examine the impact of negative workplace conditions on an organisation's operations in the context of workplace programmes and compassion satisfaction. A model is presented to explain how individual and organisational interventions mitigate the negative workplace conditions of burnout, compassion fatigue, stress and vicarious trauma on workplace performance and compassion satisfaction. This model will form the basis for further research into the negative effects of employment conditions impacting human resource managers.

Keywords: Burnout, compassion fatigue, human resources professional, stress.

INTRODUCTION

Human resources management (HRM) practices contribute to organisations' success through training, work-life and motivation combined with corporate culture, values and organisational goals. Human Resource (HR) professionals are responsible for recruitment, training, and development, and administering remuneration and employee benefits, including being abreast with employment laws and requirements with an increased focus on work-life programs designed to strategically manage the workforce (Akter et al., 2021; Ashton, 2018; Farndale et al., 2010). The alignment of HR with the business strategy, re-engineering organisation processes, communicating with employees, and managing transformation and change are primary HR functions (Ulrich, 1997). For example, understanding how burnout (BO) and compassion fatigue (CF) affects human resource personnel's work attitudes may provide practitioners with helpful information to decrease compassion fatigue and improve their empathic care at work.

There is an extensive and substantive body of work on BO, CF and related issues, but little is known about these topics regarding their impact on human resource managers. Workers face many emotional changes that contribute to CF and BO and suicide and long-term mental health issues (Maheen et al., 2021). Human resources managers are human and not immune to negative feelings such as sadness and stress. They are often at the forefront of dealing with the fallout of negative worker experiences. Still, little is known about the effect this has on managers of those affected staff.

This paper seeks to generate a model that aims to fill the literature gaps in relation to human resource managers and their work experience with regard to the construct conditions and seeks to explain how they are affected by largely unrecognised compassion fatigue and BO, which affects their psychological, behavioural and immunological conditions and these, in turn, have an impact on the organisation through increased absenteeism, higher staff turnover, reduced productivity and loss of general work satisfaction, all of which can be compensated for with increased compassion satisfaction. There are many casual attributes that affect the constructs of condition, intervention and proscriptio that impact an organisation. The casual attributes often share similar precursory triggers, and these triggers may activate more than one conditional construct simultaneously. Intervention constructs, therefore, may, through addressing one of the conditions, have a positive impact on the other conditions that were not directly targeted. It is the holistic nature of compassion satisfaction, which incorporates all interventions that has the greatest impact on the organisation in terms of resolving the construct conditions.

LITERATURE REVIEW

The effects of psychological, behavioural, and clinical conditions on workers in an organisation, in general, will be examined in terms of negative workplace conditions. Furthermore, there is an examination of the interventions that can be used to

mitigate these negative conditions, categorised into organisational supports and the role of individual commitment. The workplace outcomes of compassion satisfaction and workplace performance are reviewed.

Negative Workplace Conditions

There are four components to workplace conditions that need to be addressed by Human Resources (HR): 1) stress, a syndrome that consists of emotional exhaustion, depersonalisation and a low personal accomplishment; 2) burnout (BO), a syndrome where the individual employee suffers some form of physical and emotional exhaustion involving the development of negative self-concept, negative job attitudes, and loss of concern; 3) compassion fatigue (CF), a disorder where long-term exposure to the individual or collective organisational trauma leads to avoidance of others, intrusive thoughts, and hypervigilance, disenfranchisement, dissatisfaction and disengagement; and vicarious trauma, (VT), an acute affective disorder where the third party is actuated to parallel the trauma of the original victim.

Stress is a common and normal physical response to challenging or new situations. Stress has both mental and physical aspects. The body's stress response is also known as the 'fight or flight response when your body has adapted to respond to danger. Stress is problematic when an individual feels overwhelmed and unable to cope with a situation. Maslach and Jackson (1986) described how stress consisted of emotional exhaustion, depersonalisation, and low personal accomplishment. One of the major contributing factors to engendering stress in the workplace is the management of productivity expectations (Colvin and Thompson 2020). In HR, productivity is linked to the resolution of workplace predicaments and is measured as a level of stability, compliance, and job satisfaction of employees. While stress is derived from feelings associated with depersonalisation, dislocation, and guilt at failing to maintain performance standards within the organisation for general employees (Colvin and Thompson 2020), HR is, however, more linked to individual feelings of isolation and ostracism (Howard et al. 2020). Notwithstanding the cause of stress, the inability to cope with occupational stress results in depression and anxiety reduced job satisfaction and reduced collegial interactions, all of which are leading causes of CF and BO in the workplace (Alkhawaldeh et al., 2020; Bridger et al. 2019; Howard et al. 2020; Keesler and Troxel 2020).

Burnout occurs following prolonged, repeated exposure to stress in stressful situations and work environments, resulting in signs of fatigue, physical ailments, mood, and irritability. Burnout comes on gradually because of reoccurring stress. The term 'burnout syndrome' was introduced to describe the physical and emotional consequences of workplace stress and emotional fatigue with physical signs that included a weakened immune system leading to susceptibility to colds, reoccurring headaches and gastrointestinal problems, and behavioural symptoms of irritation, frustration, being quick to anger (Freudenberger 1974). Later, Pines and Maslach (1978) redefined BO as the physical and emotional exhaustion involving the development of a negative self-concept, negative workplace attitudes, and loss of concern for clients. The World Health Organisation added BO to the International Classification of Diseases in May 2019. It defined it as an "occupational phenomenon resulting from chronic workplace stress that has not successfully been managed", with symptoms including exhaustion, depleted energy levels and negative feelings towards work and the work environment. Therefore, BO is a condition resulting from personal and organisational stressors, producing a state of emotional exhaustion, depersonalisation and negative self-worth (Jackson and Maslach 1981; Upton 2018; Ortega-Campos et al. 2020; Silva et al. 2020).

Compassion fatigue is often associated with healthcare professionals and is primarily physical and emotional exhaustion over time. Professionals in this area report increased depression, anxiety, and stress levels due to the workplace and their role. However, the most subtle characteristic of compassion fatigue is the effect on those caring for others through empathy and compassion. Compassion fatigue, or empathetic distress fatigue, is defined as an acute affective disorder increasingly occurring among workers who work with the suffering of others (Rauvola et al., 2019; Silva et al., 2020). In HR, this is akin to the repetitive conflict and emotional distress of employees faced with scenarios of underperformance, disciplinary violations or termination. More recently, there has been a shift to the use of empathic distress fatigue to further distinguish CF from its close-related condition, secondary traumatic stress, which is often conflated (Coulter and Fitzgerald, 2019; Bridger et al., 2020; Ling et al. 2021). Figley (1995) was more explicit in his description, depicting CF as a state of emotional exhaustion regarding the negative repercussions following the intention and behavioural steps required to help a traumatised person.

Vicarious trauma (VT) occurs when individuals work with clients who experience trauma and experience a negative transformation in themselves. In 1990 the term VT was first coined by McCann and Pearlman when researching psychotherapists working with trauma survivor clients. Over the years, this expanded to include those working with trauma survivors, including first responders, social workers, health care professionals, and humanitarian workers. Unlike stress, BO CF and VT are cumulative and build up over time. Vicarious trauma can be considered an occupational hazard in workplaces where staff, such as HR managers, are repetitively exposed to traumatised employees. They may include the emotional and psychological effects of workplace-induced injury and its ongoing management and litigation, leading to ongoing indirect exposure to the details of others' traumatic experiences). The concept of vicarious trauma was first introduced by Pearlman and Saakvitne (1995) and is often used interchangeably with CF and BO. Notably, while the conditions of CF can contribute to BO and negatively affect workplace outcomes and lead to a period of absenteeism, VT.

On the other hand, it may lead to the worker having to exit the workplace permanently due to an inability to cope (Stamm 1999; Figley 2002b; Bride 2007; Adams et al. 2008; Hunt et al. 2019; Rauvola et al. 2019). Therefore, the differentiating factor between the concepts is: that BO emerges over time and results from the stresses of the work environment; CF results from

exposure to human suffering, and VT is the personalisation of third-party trauma. Each of these (BO, CF, and VT) can be managed and lead to recovery if identified and addressed early. However, the recovery time differs substantially, with VT being the most extended enduring condition (Rauvola et al., 2019; Silva et al., 2020).

Interventions - Organisational support

There are three organisational supports that can be used to mitigate negative workplace conditions: 1) workplace support, where the employee has a sense of being cared for and belonging to the organisation; 2) mindfulness, where individuals are encouraged to build internal resilience and develop coping strategies; 3) self-care, the organisation has a responsibility to encourage through the provision of specialised programmes that enhance an individual's ability to develop internal strength to deal with workplace stressors.

Supportive workplace environments strongly affect the individual's perception of positive and negative situations (Buckley et al., 2020). Workplace social support is more than regular staff meetings; workplace settings may not be safe to share personal impacts and challenges regarding daily tasks without the risk of being seen as weak or incompetent (Pace et al., 2019; Brend and MacIntosh, 2021). Similarly, a lack of support and guidance from supervisors and limited opportunities for personal development, coupled with task density (Kheswa 2019). In particular, workplace social support has five prerequisite needs to be available to assist the individual (Brend and MacIntosh, 2021): 1) to feel safe from fear of reprisal or judgment; 2) to have a sense of being cared for with support from colleagues, such as invitations to sharing experiences; 3) to knowingly have available and dependable trustworthy supports; 4) to have non-judgemental interactions when encountering difficult workplace encounters, and 5) to have a level of autonomy in scheduling to manage tasks and create affirmative control of the workers personal and professional choices and processes. Similarly, there are four key aspects required of the support person within the workplace (Brend and MacIntosh, 2021): 1) a necessity to have both knowledge and practical experience within the discipline that the clients are engaged in; 2) a high degree of emotional management to deal with the expose to distressing client narratives, and 3) the ability to assist clients in making sense of their feelings and thoughts to bring alternative pathways to show that the work is making a difference, and 4) to validate the personal experience of the worker. Fundamentally a workplace that consists of a fractured community lacks the spirit of togetherness needed to build strong social support (Florian et al., 2019).

The use of short courses with didactic and experiential mindfulness education via a structured, skills-training course delivered in a group setting has been found to be effective in managing BO (Alkhaldeh et al., 2019). Mindfulness-based interventions, resiliency programs, and coping strategies could be beneficial to organisations through wellness programs and build resilience, self-compassion and greater cooperation and supportive culture within the workplace setting, as well as increased empathy (Wahl et al., 2018; Rauvola et al., 2019; Miller et al. 2020). Those individuals within the workplace with greater mindfulness had increased self-kindness, less self-judgement, and reduced levels of isolation through avoidance (Miller et al 2020). Mindfulness-based interventions are cost-effective to implement and, therefore, can be scaled and implemented in a range of organisations (Rohlf, 2018; Grimes, 2019; Rauvola et al., 2019).

Self-care is a broad concept, referring to individual responsibilities for healthy lifestyle behaviours, encouraged and supported through internal organisational programmes that are required for human development and functioning and those activities required to manage acute and chronic healthcare conditions. Backman and Hentinen (1999) found that patients identified four levels of self-care performance: responsible, formally guided, independent, and abandoned. Other qualitative studies on the meaning of self-care to patients have identified themes such as "body listening" or monitoring of bodily cues, managing social context and lifestyle, having control over treatment, taking care, and not harming self (Leenerts & Magilvy, 2000; Thorne, Paterson, & Russell, 2003). Self-care has been found to significantly impact moderating the effects of BO and CF through the build-up of coping resources (Bridger et al. 2020). Self-care is a process of being and reflecting on oneself through exercise, meditation, and journaling (Buckley et al., 2020). Behaviours that were found to be significant in fostering self-care were found to be: attire, seeking medical assistance when necessary; regular meals; listening to self; finding amusement; contact with significant others; spending quality time with others; recreational activities; meaningfulness in actions; focusing on non-materialistic aspects of life; singing; accepting ones knowledge limitations, and being inspired; having hope; having pets or companion animals (Keesler and Troxel, 2020).

Furthermore, an important aspect of self-care is the need for defined boundaries that are supported at the administrative level, such as time off and an organisational recognition of the unpredictability of workloads (Colvin and Thompson, 2020). Supervisors have a key role in promoting individual competence in self-care and managing stress and other factors contributing to BO and CF through training (Kabadayi et al., 2019; Colvin and Thompson, 2020). Furthermore, the role of self-care is to enable the building of coping mechanisms to deal with emotions and promote self-management by constructing internal barriers that protect against negative emotions (Font-Jimenez et al., 2019).

Interventions - Individual Commitment

There are three individual commitments that can be used to mitigate the negative workplace conditions: 1) spirituality, where the employee is encouraged to see the broader picture of their contribution rather than become entrenched and focused on one particular workplace issue; 2) resilience, a reflection on the individuals' ability to process negative emotions encountered in the

workplace and avoid feelings of guilt and negative self-harming actions of self-denial ; 3) empathy, having the ability to figuratively to walk in another person's shoes without wearing them.

Spirituality means different things to people. It has a broad concept with many perspectives. Mostly, it is associated with having a connection to something bigger than us. Searching for the meaning of life and there is extensive literature on spirituality Delaney (2018). Engagement within the workplace brings self-satisfaction, and this can increase spirituality and has three dimensions:

- (1) Meaningfulness, sense of return on investments of self in role performance;
- (2) Safety, feeling of being able to show and employ self without fear of negative consequences to self-image, status, or career; and
- (3) Availability, a sense of possessing the physical, emotional, and psychological resources necessary for investing self in role performances (Adnan et al. 2020, p. 4).

Where is a lack of engagement, fatigue can be induced by external forces, such as the organisation carrying out a particular task that carries a negative emotion in relation to fulfilling that task (Adnan et al., 2020). In contrast, Compassion is a key to engagement and achieving connectedness within the workplace. With it, a sense of meaningfulness and vigour in addressing difficulties encountered gives rise to workplace satisfaction through increased passion, enthusiasm, and commitment (Adnan et al., 2020).

Resilience measures the individual's ability to recover from life stressors (Kapoulitsas and Corcoran, 2015). It is grounded in the hardiness of an individual to recover following exposure to a negative emotion-generating situation (Bridger et al., 2020). Therefore, a high degree of interpersonal characteristics is involved in building an individual's resilience, such as the ability to adapt, interpersonal skill levels and the ability to withstand adversity (Keesler and Troxel, 2020). Resilience often means the ability to cope with guilt and self-denial, which fosters the chronic disrepair that comes with the repairing of others (Gerard, 2020). Resilience is also correlated with mindfulness, self-compassion, and self-care (Miller et al., 2020). Resilience is the ability to adapt to environmental changes physiologically and psychologically. It is a survival skill required of every member of the animal kingdom. In humans, it is often manifested as the difference between individuals' conceptualising themselves as survivors versus victims; that is, the difference between individuals who can take care of themselves and others versus individuals unable to care for themselves when subjected to substantial stressors Ginzburg 2012. Resilience measures the individual's ability to recover from life stressors (Kapoulitsas and Corcoran, 2015). It is grounded in the hardiness of an individual to recover following exposure to a negative emotion-generating situation (Bridger et al. 2020). Therefore, a high degree of interpersonal characteristics is involved in building an individual's resilience, such as the ability to adapt, interpersonal skill levels and ability to withstand adversity (Keesler and Troxel, 2020).

Empathy is the process when you are imaginatively able to place yourself in another's role and situation to understand the other's feelings, points of view, attitudes, and tendencies to act in a given situation. Burnout and CF can be mediated with empathetic perspective-taking through the building of interpersonal relationships; however, this can also have the converse effect of increasing the risk of losing perspective and becoming personally involved (Bridger et al., 2020). The tone and structure of the language have an impact on how empathy is engendered within the workplace, with the necessity to have a "voice of empathy", which is non-confrontational, non-organisational and personalised speech (Caringal-Go and Canoy, 2018). In contrast, the "voice of resolve" is the voice of management; it strives toward efficiency and process, accepts responsibility, and is seen as human resources orientated, reinforcing policies and procedures (Caringal-Go and Canoy, 2018). These two voices are often in conflict, making empathetic relationships often ambiguous and leading to the voice of uncertainty, where staff disenfranchisement is engendered with the process of expressing personal expression in the workplace (Caringal-Go and Canoy, 2018).

Outcomes

Two possible outcomes affected by workplace conditions and the interventions that mediate their effect on individuals are workplace performance and compassion satisfaction. Workplace performance is a measure of the employee's workplace achievement in terms of performance targeted and meeting the strategic goal of the organisation. Compassion satisfaction deals with the employee's positive feelings that come with helping others in the workplace.

Workplace performance measures how individual work performance is aligned with the organisation's performance targets and strategic objectives. Workplace conditions, employee attitudes, and stakeholder interactions can affect work productivity (Saunila et al., 2014). For example, working under the influence of exhaustion due to negative workplace conditions can lead to a sense of spatial dislocation that engenders presenteeism (Aboagye et al., 2019). Presenteeism refers to an employee's physical presence, but their actual work performance indicates their absence (Aboagye et al., 2019). Workplace ostracism, and its sister workplace loneliness, are often a consequence of an individual's withdrawal and are reflected in poor workplace performance (Uslu, 2021). Where the employee can mitigate the effects of negative workplace conditions through targeted interventions, there is a corresponding increase in their workplace dignity that direly leads to increased productivity and social interaction (Ahmed et al., 2022).

Compassion Satisfaction (CS) is used to describe the positive aspect one gets from doing the work of helping others (Stamm, 2005). Skills to acquire CS can result from early intervention training, including specific coursework and case presentations that address the BO, CF and VT, specifically in graduate programmes (Clemons, 2020). Importantly, workplace feedback, praise, and a sense of appreciation for achieved tasks help build a sense of CS and ameliorate self-focused personal distress and inclusivity from those they are exposed to in the workplace (Coetzee & Laschinger, 2018). Furthermore, workplace bullying can undermine attempts to build institutional CS (Coetzee & Laschinger, 2018; Chachula, 2020). Therefore, it is the role of every individual within an organisation to foster CS, and it should be seen as a duty of care within the workplace.

HYPOTHESIS DEVELOPMENT

Therefore, it can be demonstrated that four primary relational hypotheses can be developed in relation to how human HR professionals cope with their workplace conditions. These relational hypotheses can be modelled (Figure 1) and formulated as:

- 1) The negative workplace effects on HR professionals can be mediated with organisational support, and this leads to increased compassion satisfaction;
- 2) Improved individual commitment can mediate the negative effects of workplace conditions and improve compassion satisfaction;
- 3) The work performance of an HR employee is directly linked to the organisational support that reduces the effects of negative workplace conditions; and
- 4) The individual commitment shown by an HR employee to mediate the negative workplace conditions can lead to improved workplace performance.

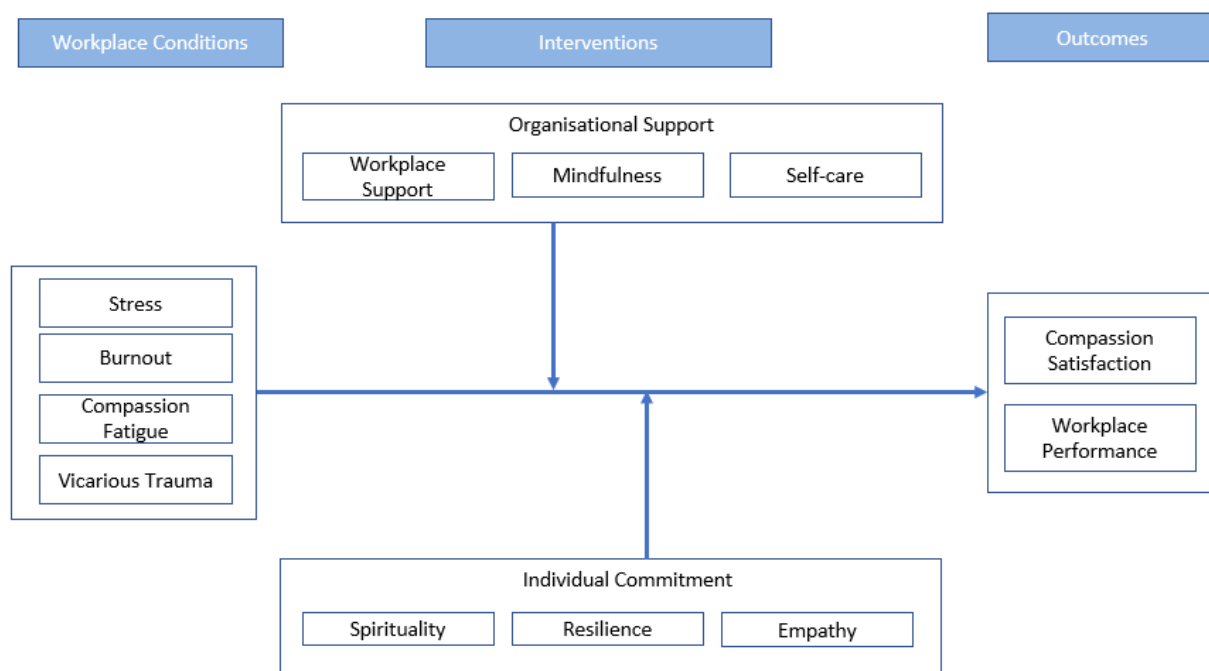


Figure 1: The modelling of negative workplace conditions on HR workers and the organisational and individual interventions that generate positive outcomes in the workplace quantified by compassion satisfaction and workplace performance.

CONCLUSION

This paper presents a framework for understanding workplace performance and compassion fatigue that can be applied to underpin the modelling of the effects of BO and CF on HRM. There is a plethora of literature on the BO and CF in diverse organisational frontline settings, but scant information about how this affects the human resource managers who have to deal with them daily. There is a strong interrelationship between BO, CF and their auxiliary conditions. At the same time, the interventions applicable to BO and CF also have the benefits of addressing the problems of post-traumatic stress disorder, stress, secondary traumatic stress and vicarious trauma. Similarly, the interventions are integrated and often linked, so the treatment of BO and CF will necessitate more than one focal intervention to gain maximum workplace resolution. This combined intervention approach leads to a sense of compassion satisfaction. By increasing compassion satisfaction, an organisation can reduce absenteeism, improve work satisfaction, improve productivity, and reduce staff turnover. This leads directly to retained institutional knowledge and a more efficient, effective and harmonious workplace.

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Preserving talent: Employee churn prediction in higher education

(Work-in-Progress)

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ABSTRACT

Retaining employees in a knowledge-based organisation, such as a university, is a significant challenge, especially as the need to keep knowledgeable workers is key to sustaining their competitive advantage. Knowledge is the organisations' and employees' most valuable and productive asset, but this intrinsic character leads to a high employee turnover. Often, universities learn about employees' imminent departure too late. To prevent the loss of high-performing employees and to detect the warning signs early, business firms have been using advanced data mining techniques to predict "customer churn". Recently these techniques have been used with "employee churn" in various industries, but not in higher education. This research bridges this gap by applying data mining techniques to predict employee churns in a university. The contributions of this research will be: 1) to identify critical factors that lead to talent losses; 2) to help universities devise appropriate strategies to retain their employees' talents.

Keywords: Employee attrition, churn prediction, higher education, data mining.

INTRODUCTION

Retaining employees in a knowledge-based organisation, like a university, is a significant challenge. For universities, retaining knowledge workers is key to sustaining their competitive advantage. Knowledge is the employees' most valuable and productive part, but this intrinsic character leads to turnover. Often, universities learn about imminent departure too late. Disruptions in higher education signify an increased need for a university to retain high-performing employees to remain competitive. For example, the growth of postsecondary alternatives to further education, including Massive Open Online Courses (MOOCs), industry-driven certification programs and coding boot camps, offers a broad range of options for learning. While online learning platforms, such as Coursera, provide additional channels for universities to reach students, they also invite competition to universities as companies are now offering similar content to those offered by universities.

Moreover, there has been a significant change in how people view their work and the actual purpose of work during and after the COVID-19 pandemic. Recently, 41% of employees globally are considering leaving their jobs, and 36% of those leaving their jobs do so without having their next job available (Frick et al., 2021). Therefore, organisations are going to need to update their 'retention of talent' strategy to retain valuable employees, and universities are no exception. As an organisation strives to keep its valuable employees or "top performers", human resource management becomes critical as it helps an organisation to preserve talents to sustain its competitive advantage (cf. Sooraksa, 2021).

Universities are competing for talent. In the age of a knowledge-based economy, the need for 'creative knowledge' workers has skyrocketed. Employees' skills have now become a critical determining factor for the survival of an organisation (Holdford, 2019). Realising the value of talented employees, companies have started to leverage 'people analytics' and digital technologies in different ways. For example, Unilever, a European-based consumer goods company, uses digital solutions to increase administration and employee engagement. Saudi Aramco, Saudi Arabia's national petroleum and natural gas company, has adopted virtual reality (VR) and gamification for training their employees (Patwardhan et al., 2019). Microsoft uses "Workplace Analytics" to measure how work patterns across teams change to improve the employee experience. Google is among the pioneers who use people analytics intensely to help to profile its employees. Google has an array of initiatives, such as devising predictive models to forecast upcoming people management problems and opportunities, analysing people data to improve diversity and developing a mathematical algorithm, which proactively and successfully predicts which employees are most likely to become a retention problem (Grace, 2022).

While a growing number of examples and papers demonstrate how private companies are moving towards people analytics, less is known about how the public sector, particularly universities, utilises people analytics to retain top-performing employees. In addition, research on predictive analytics for employee churn is growing and is still attractive for academia and practitioners. An analysis of existing predictive employee churn research points towards an opportunity for future research since the nature of datasets and the context of an organisation significantly affect the prediction. However, it is unlikely to be a comprehensive predictive employee churn model that can be used across different organisations. Therefore, this research is designed to bridge this knowledge gap and create a predictive employee churn model for a public research university. The

outcomes from this research can: 1) identify critical factors that lead to losses of talent; 2) help universities devise appropriate strategies to retain their talents.

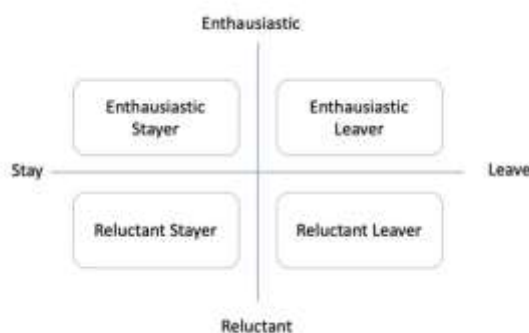
LITERATURE REVIEW

Employee Attrition

Retaining talented employees is a constant challenge for every organisation. Research studies seek to understand factors causing employees to leave an organisation. A wide range of factors has been suggested as predictors for an employee to quit. These factors include individual attributes such as personal characteristics and demographics, perceptions, and performance, as well as the attributes of the institutional environment, such as the organisation’s structure, reward systems, and competition in a labour market – creating constraints and opportunities for individuals moving to a new job.

Theories on voluntary employee turnover have advanced consistently. In 1958, James March and Herbert Simon proposed ‘perceived desirability’ and ‘ease of movement’ as two primary constructs to suggest why employees stay with an organisation. These two constructs, later, are construed as ‘job (dis-) satisfaction and ‘actual job alternatives’ consecutively. Later, Mobley (1997) suggests how job dissatisfaction culminates in a high turnover and explains how employees depart (Lee et al., 2017). Intermediate linkages such as subjective expected utility (SEU) analysis of the benefits and costs of seeking new jobs and search intentions have been proposed (Lee et al., 2017). Prior to job dissatisfaction, such as pay, centralisation, and alternative available employment, were identified as factors driving job (dis -) satisfaction. Based on cost/benefit analysis alone, although employees might be dissatisfied with their current jobs, they will not switch to new jobs if they anticipate future promotions in their existing job, or if there are worse payoffs from the new job.

Another strand of research examines ‘why’ (rather than how) employees leave (e.g., Price, 1989; Beach & Connolly, 2005; Lee & Mitchell, 1994). According to Lee and Mitchell (1994), there are four paths an employee might take in terms of deciding whether to leave a job. The first path is based on the classic dissatisfaction-induced leaving. The remaining three alternative paths are based on ‘shock’ – the jarring event(s) evoking thoughts of leaving. In Path 1, employees leave because a shock activates a pre-existing plan. Path 2 occurs when (an) undesirable event(s) prompt immediate quitting. And in Path 3, outside job offers cause employees to question their current job commitment. Hom et al. (2012) propose Proximal Withdrawal States Theory (PWST) to classify various mindsets about remaining or leaving an organisation. Simply put, there are four archetypal mindsets: 1) enthusiastic stayers (i.e., “I want to stay, and I can stay”), 2) enthusiastic leavers (i.e., “I want to leave, and I can leave”), reluctant stayers (i.e., “I want to leave, but I have to stay”), and reluctant leavers (i.e., “I want to stay, but I have to leave”), which can be depicted as Figure 1.



Source: This study
Figure 1: PWST matrix.

Drawing from the above two strands of literature, a meta-analysis of research in turnover research during 1995 – 2008 (Holtom et al., 2008) shows six categories of antecedents of job turnover (see Table 1).

Table 1: Factors that lead to employee churn.

No.	Categories	Factors
1	Individual Difference	Ability, biodata/attribute, personality
2	Nature of the job	Routinisation, job scope, autonomy, role states
3	Traditional Attitude	Job satisfaction, met expectations, organisation commitment, job involvement,
4	Newer attitude	stress & strain, exhaustion & well-being, psychological uncertainty, change acceptance/perceptions, challenge/hindrance stressors
5	Organisational/Macro	Organisation size, group cohesion, demography, reward system, organisation culture, organisation prestige, climate, unit-level attitudes, normative/institutional pressures
6	Person-context interface	Justice, leadership, attachment/ties, person fit, realistic job preview, interpersonal relations, position history, socialisation

Source: Holtom et al., 2008

Lee et al. (2017) contend that previous research has proposed many factors that cause people to leave their work. Future research should embrace the varied research designs and analytical tools available to push the knowledge forward. The availability of big data and advanced data analytic tools provide greater opportunities for researchers to be innovative about gaining valuable insights into employee attrition.

Data Mining Employee Churn

Predictive models are now widely used in many business domains to predict occurrences of events, including predicting employee churn. The techniques for predicting employee churn have been ported from those used to predict “customer churn”. Customer churn is a key problem in highly competitive service markets (Saradhi & Palshika, 2011). A voluntary churn happens when customers stop using a company's current services and switch to a competitor company's services. It is critical to solve this problem because acquiring new customers is more complex and expensive. Losing customers leads to loss of revenue, which in turn negatively affects the ‘bottom line’. In the same vein, “employee churn” is when an organisation loses its “internal customers” – i.e., the employees. Losing employees incur additional costs for an organisation, such as recruitment costs, onboarding costs, lost productivity, lost engagement and employee morale, training costs, and lost institutional knowledge.

Using data mining and machine learning allows an organisation to identify high-performing employees who are suddenly about to leave. Machine learning algorithms can be categorised into two groups: supervised machine learning and unsupervised machine learning. Supervised machine learning requires labelled input and output data, or the “training dataset”, during the training phase. The algorithm will learn about the relationship between input and output and construct a model, as this type of learning is called supervised learning, because it requires human oversight. Conversely, unsupervised machine learning does not require labelled input and output data. Algorithms of this type will recognise patterns in a raw dataset and construct a model based on the identified patterns. This approach is often used in the early exploratory phase to better understand the datasets (Provost & Fawcett, 2013). Employee churn prediction falls into the supervised learning category. The machine learning algorithms are fed with the training dataset containing multiple attributes and the label indicating which employee is already left and which are still with an organisation (Ekawati, 2019).

Existing literature shows that the commonly used data mining techniques for predicting employee churn are: Naïve Bayes, decision tree and random forests, logistic regression, and Support Vector Machine (SVM).

Naïve Bayes

In the literature on machine learning, naive Bayes is a common classification technique that has gained popularity for its effectiveness and simplicity (Mitchell, 1997). *A posteriori* probabilities are calculated using this procedure for each class. In predicting employee churn, these are the chances of seeing churn and non-churn, given an employee record. These *a posteriori* probabilities are calculated using the Naive Bayesian assumption and the Bayes rule for each class given a specific employee record. As a result, the learned function ‘*f*’ is nothing more than a probability table. The conditional independence of the attributes used to describe employees is a crucial presumption in the Naive Bayes classifier. This method has been used in numerous case studies, particularly in the wireless telephony sector. However, it has only moderate success in predicting employee attrition (Fallucchi et al., 2020).

Decision Tree and Random Forests

Decision trees are popular in the literature, because of their simplicity in interpreting the discovered rules. Given a training data set, this learning technique produces a tree where each node represents an *n* attribute, and each branch represents a value for that property. The decision tree nodes are determined by the explanation power of the attributes (as evaluated by an information gain number) (Duda et al., 2001). The primary issue with the decision tree learning technique is its instability. Little changes in the training dataset typically result in substantial variances in classification performance. To solve this problem, Breimen proposes

“random forests” (Breimen, 2001). The objective of random forests is to generate numerous decision trees using sampled data (via bootstrap resampling) using only a subset of attributes. The final model is derived from the combination of the decisions of each of the constructed trees (using a voting-based approach).

Despite their instability, decision trees have been used in many case studies. Taiwan cellular telecommunication uses decision trees to estimate client turnover (Hung et al., 2006). The data was collected from 160,000 customers with an 8.75% customer attrition rate (14,000). Attributes for constructing the model include demographic information (age, tuner, and gender), billing payment history, call details, and customer care service characteristics. In this study, the performance of random forests is very high, at 98%. Random forests are also effective in other cases, such as predicting newspaper subscriptions (Lariviere & den Poel, 2005) and customer churn in the banking industry (Courssement & den Poel, 2008).

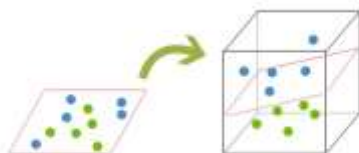
Logistic Regression

Logistic regression is a multivariate statistical technique that predicts group membership in a dichotomous dependent variable, given a collection of independent variables. Logistic regression is superior to other statistical methods when classifying data into a binary dependent variable. Multiple linear regression, for instance, assumes the normal distribution of the dependent variable and the linear relationship between the independent and dependent variables. These assumptions are not established during logistic regression model development. When the data are not normally distributed, and the dependent variable is binary

(i.e., predicting employee churn), logistic regression could be an effective technique, as the dependent variable is dichotomous. Quinn et al. (2008) use logistic regression to predict case worker and supervisor turnover in human services agencies. To develop the model, they used the first 429 cases as the training dataset and the remaining 109 cases to validate and test the model. The results show that the logistic regression model could predict employees who left the agency with 79% accuracy. However, the prediction was more accurate when considering the number of stayers only, at 92%. Attributes included in the analysis were demographic data, such as age, education, gender, and country, and several job-related attributes, such as job type, length of tenure, and current rank in the agency.

Support Vector Machine (SVM)

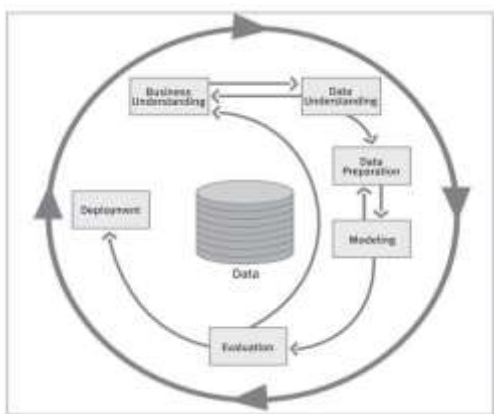
A Support Vector Machine (SVM) is a supervised learning algorithm that can be used for classification and regression, but it is commonly used in classification problems. The key concept of SVM is that it will find a “hyperplane” that best divides data into two classes. Support vectors are the nearest two data points (one from each side of the hyperplane) next to the hyperplane. Removing the support vectors would alter the position of the hyperplane. In essence, a hyperplane is a line that linearly separates and classifies a set of data (in a two-dimensional view), or it is a plane that classifies a collection of data (in a three-dimensional view) (see Figure 2). A distance between support vectors and a hyperplane (or a line) is called “margin”. The primary goal of SVM is to maximise the margins of the support vectors so that it can separate two datasets as much as possible. Saradhi and Palshika’s (2011) study shows that SVM, when used to predict employee churn, could outperform other algorithms, such as random forests and Naïve Bayes.



Source: www.towardsdatascience.com
 Figure 2: SVM hyperplane.

RESEARCH METHOD

This research follows the CRISP-DM reference model to create an employee attrition prediction in the context of higher education. CRISP-DM stands for Cross-Industry Standard Process for Data Mining. CRISP-DM, also funded by the European Commission, was intended to be industry-tool and application-neutral. Currently, a CRISP-DM consortium puts the CRISP-DM methodology forward, and this methodology is well accepted among practitioners and academia (Chapman et al., 2000). CRISPDM views a data mining process as a life cycle consisting of six stages (See Figure 3): 1) business understanding; 2) data understanding; 3) data preparation; 4) modelling; 5) evaluation; and 6) deployment. In reality, CRISP-DM is proven to be an effective process. It at least provides general guidelines that are useful for planning, documentation, and communication (Wirth & Hipp, 2000). We will follow CRISP-DM up to step five since model deployment at the university level would require greater collaboration from different units and demand more significant resources.



Source: Cross-Industry Standard Process for Data Mining
 Figure 3: CRISP-DM Life Cycle.

The Business Understanding Stage

In this stage, the business objective is clarified, and the criteria for success are clearly defined. For this research, the main goal is to use data mining techniques to find an appropriate model to predict employee attrition in a public research university. We collected data from one of the top research universities in Thailand. In 2022, the university has approximately 12,000 employees, classified into three main groups: faculties, supporting staff, and professional staff.

The Data Preparation Stage

We gathered data from the human resource database of the university mentioned previously. The database contains approximately 15,904 employee records, including 2,750 churners and 13,154 non-churners, accumulated from 2015 to 2022. The data include 18 attributes for each employee record, as in Table 2 below.

Table 2: Human Resource Dataset Attributes

No	Features/Characteristics	Description	Data Type
1	Record ID	Unique record ID	Categorical
2	Sex	Gender	Categorical
3	Nationality	Nationality	Categorical
4	WorkLineID	Employee's line of work (e.g., academic, supporting)	Categorical
5	MarriageStatus	Marital status (e.g., single, married)	Categorical
6	EmployeeTypeID	Employee types (e.g., permanent, temporary)	Categorical
7	Education	Education level	Categorical
8	Age Range	Age range (range of 10)	Categorical
9	Work time	Years of stay with the university	Numeric
10	Salary Range	Salary range (range of 10,000)	Categorical
11	SubEmployeeType	Employee types (e.g., permanent, temporary, retired)	Categorical
12	Academic Main Group	Fields of study (e.g., health science, technology, social science and humanity)	Categorical
13	Welfare	Amount of financial benefit received each year	Numeric
14	LeaveDay	Number of annual leave days	Numeric
15	Performance	Performance evaluation results (e.g., excellence, good, fair, poor)	Categorical
16	Salary Raised (percentage)	Percentage of salary raised	Numeric
17	Tenure	Tenure position or not	Categorical
18	Stay/Left	Stay or left	Categorical

Source: This study.

One-hot Encoding

One-hot encoding is a method to convert categorical data variables to improve a model's prediction and classification accuracy. Many machine learning models do not take categorical values as their inputs, so they must be converted into numbers. However, the conversion could hamper the prediction model's performance, because the model might see these values as having an ordinal relationship while they do not. One-hot encoding is designed to solve this problem. The one-hot encoding creates a new binary feature for each possible category and assigns a value 1 to the feature of each sample that corresponds to its original category. One-hot encoding is a crucial feature engineering procedure. For example, a feature containing values for three colours, "red", "green", and "blue", can be encoded into a three-element binary vector as Red: [1, 0, 0], Green: [0, 1, 0], Blue: [0, 0, 1]. It should be noted that one-hot encoding might not be appropriate for a feature that has too many categorical values. When the cardinality of the categorical features is large, a dictionary that maps categorical features will be large and can significantly strain a computer's memory resources (Weinberger et al., 2009). Having acknowledged this limitation, we will convert all features with categorical attributes using the one-hot encoding technique, since the cardinality of these features is not considered as high, and our computing resources can handle this amount and complexity of data.

Feature Selection

Feature selection will be used to eliminate redundant features to improve model accuracy. This process could involve many statistical techniques. The process involves building various models with different subsets of training features to build a more accurate classification model. For example, Trivedi (2020) performs a study on the credit scoring model with a different feature selection approach. Using freely available data - the German Credit dataset, the researcher uses three feature selection techniques (i.e., Information Gain, Gain Ratio, and Chi-Square) to choose the best subset of features from the dataset. After comparing the three techniques, she found that the Chi-Square feature selection is the most suitable for the German Credit dataset. This result should be interpreted cautiously, since it has not been generalised to other datasets. We will perform the feature selection process to firstly improve the model's accuracy and, secondly, to identify key factors that lead to voluntary leave.

The Modelling Stage

In this phase, we will use four machine learning algorithms, including Naïve Bayes, decision trees and random forests, logistic regression, and SVM, commonly adopted techniques for predicting employee churn. At this stage, we will need to calibrate our models and optimise the parameters of each model. Also, we will have to move back and forth between this stage and the data preparation stage, since each model can handle certain data types. Data conversion and data transformation are expected.

The Evaluation Stage

At this stage, we will compare the results from the four machine-learning algorithms and examine which algorithm yields the best outcome for our employee churn prediction problem. We will use the “*area under the receiver operating characteristics curve*” (ROC-AUC) to measure the performance of the models. AUC is a general measure of ‘predictiveness’. It is preferable to other metrics (such as error rate), because it measures the probability that a classifier ranks a randomly chosen positive instance higher than a randomly chosen negative one (Punnoose & Ajit, 2016). We will use the “*lift chart*” to visualise the improvement of a particular model when compared with a random guess.

CONCLUSION

This research establishes that it is necessary for knowledge-based organisations, particularly universities, to retain their highperforming employees. These employees are essential for universities to sustain their competitive advantages in the era of highly competitive and disruptive environments. Universities need to re-consider their people management strategies and prevent unnecessary losses of employees. Machine learning and data mining techniques are helpful tools that allow universities to predict the voluntary leaving of high-performing employees. Nonetheless, research in predictive analytics in employee churn is still scarce. There is still a need to improve the accuracy of employee churn prediction, and there should be more cases from a wide range of industries (Ekawati, 2019). To advance this field of study, we will create a predictive model for employee churn in the context of a public research university. The results of our research will be beneficial in at least two ways. First, from the theoretical perspective, it will allow us to identify the key factors that lead to voluntary leave. Second, from a practical standpoint, the university can use the results as input to initiate appropriate people strategies to retain valuable employees and their talents.

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Promoting consumers' online brand attention: The study of spatiotemporal analysis in regional apples

(Work-in-Progress)

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ABSTRACT

With the application and promotion of agricultural products e-commerce, it is of great significance to increase the popularity of brand recognition to promote the market value of agricultural products. Online attention is an important form of regional brand awareness of agricultural products on the Internet. Taking the apple industry as an example, this paper uses 6 years of data from the Baidu search index to analyze the spatiotemporal characteristics of apple brands in China. The study has demonstrated a way to analyze online brand attention and its relationship with regional brands. Further studies are to be made in more detailed attributes associated with the forming of attention to enhance the online brand attention and promote agricultural products.

Keywords: Agricultural products, online brand attention, regional brand, spatiotemporal analysis.

INTRODUCTION

In recent years, the rapid development of e-commerce technologies has facilitated to build of new marketing channels for agricultural products. In addition, with the popularity of e-commerce and mobile payment, the online market scale of agricultural products has gradually expanded. At the same time, the e-commerce market competition for agricultural products is intensifying. As the carrier of agricultural product information, Internet has gradually become another core competitiveness of brand promotion for agricultural products in addition to price and quality (Mina Tajvidi et al., 2020). Brand image is an important clue for consumers to judge product quality and plays a positive role in promoting sales and consumers' willingness to buy (Ng & Wang, 2013; Zhang, 2015). The production of agricultural products has strong regional characteristics and resource dependence (e.g., wine products: see Johnson and Bruwer, 2007 & Canziani, & Byrd, 2017). A regional brand of local agricultural products directly reflects the origin characteristics, cultural characteristics, unique quality and reputation value of agricultural products in the region. Thus, the regional brand is of great significance to transform the industrial advantage of regional agricultural products into market value (Wang et al., 2022). Online promotion of agricultural products provides a favorable environment for the construction of regional brands of agricultural products. Improving the regional brand images of agricultural products via Internet platforms such as e-commerce sites and social network apps, has become a topical issue that draws much attention from academia and the industries.

The regional brand of agricultural products can be defined as "the sum of the goodwill of the brands of agricultural enterprises (or families) with considerable scale, strong production capacity, high market share and influence formed in a certain region, usually in the form of 'regional name + category name'" (Pyzhikova, et al. 2020). Existing studies have shown that product quality, service quality and social experiences are the key factors affecting the regional brand building of agricultural products in the e-commerce environment (Tolba, 2015; Margarisová, & Vokacova, 2016; Zhang et al., 2019). Agricultural products with a strong regional brand image generally have a better market value (e.g., a selling price) than others (Pyzhikova et al., 2020) as brand image can boost the brand equity which leads to revenues and profits (Faircloth et al 2001). When consumers have a sense of identity for certain agricultural products with a regional brand, such a regional brand can enhance the trust between consumers and producers (Shang et al., 2018). For consumers, the higher the brand awareness, the higher their perception of the brand value and the stronger their willingness to make online purchases (Wang et al., 2022). In this sense, brand attention on the Internet is a representative form of brand awareness (Huang et al., 2020). Therefore, a deep understanding of the agricultural product distributions with a regional brand on the Internet can enrich research on regional brand development of agricultural products from the perspective of consumers.

One of the high-value agricultural products is apple. Because of policy support, market incentives and the adoption of new agricultural technologies, there has been a major increase in the China's apple market productivity and thus tends to reach supply-demand balance and as a result, intensifies the competition in the apple market. Thus, accelerating the promotion of apple regional brand awareness is of great significance to ensure the income of apple growers and improve apple production efficiency. Therefore, the purpose of this paper is to reveal the spatial-temporal distribution of online brand attention for

China's region's apple brands. The findings can be used to formulate marketing strategies and have implications for further improving apple's brand promotion.

DATA SOURCES AND RESEARCH METHODS

Data source

China's apple planting area and yield account for about 50% of the world's total. The country has 25 out of 31 provinces that produce apples. The Bohai Bay and the Northwest Loess Plateau are two dominant apple production areas in China, from where this study selects four regional apple brands as the research objects, i.e., Luochuan apple, Yantai apple, Huaniu apple and Aksu apple.

By December 2021, China's search engine users reached 829 million, accounting for 80.3% of the nation's total Internet users with Baidu search ranking at the top in the search market share (China Internet Network Information Center, 2022). The user search behavior using Baidu search engine can reflect the user's attention on certain products to a certain extent. Therefore, this paper indirectly reflects the consumers' online attention to regional apple brands based on the search index data of relevant apple regional brands provided by Baidu Index (index.baidu.com). Baidu Index is a data-sharing platform based on the behavior data of millions of users. It shows the historical search volume of a certain keyword on Baidu. Users can use Baidu Index to study the trend of keyword searches, gain insight into changes in Internet users' demand, and analyze market characteristics from the perspective of consumers.

The data used in this study was collected from the Baidu Index platform. In particular, the Baidu composite index is considered as online attention of Apple brands in various regions. The data consists of the daily Baidu composite index of "Luochuan apple", "Qixia apple", "Gansu apple" and "Aksu apple" in 31 Chinese regions between January 2013 and December 2019 (note: data of other periods were affected by the subsequent Covid-19 pandemic).

Analysis method

Gini coefficient is a common indicator for measuring the income gap of residents in a country or region. In this study, Gini coefficient is used to measure inter-provincial differences in regional apple brands' online attention. Its formula is as follows:

$$G = \frac{1}{KW} \sum_{k=2}^K \sum_{j=1}^{k-1} (Q_k - Q_j) \quad (1)$$

Where: G is the Gini coefficient; W is the sum of a regional apple brand's online attention in K provinces; Q_k and Q_j are online attention of the kth and jth provinces ranked from low to high, respectively. The greater the Gini coefficient, the greater the difference in attention on a regional apple brand among provinces.

Herfindahl index (H) is a comprehensive index to measure the degree of concentration, which reflects the degree of agglomeration of regional economic scale indicators. The value of Herfindahl index ranges from 0 to 1, where the closer to 1, the lower the degree of regional economic agglomeration.

$$H = \sum_{i=1}^N P_i^2 \quad (2)$$

Where: P_i is the ratio of the total number of indicators in a certain region. The closer H is to 1, the higher regional concentration of the regional apple brand's online attention.

Temporal analysis of regional apple brands' online attention

Weekly variation analysis

The weekly distribution of each regional apple brand's online attention is calculated by averaging the weekly Baidu indexes of the four apple regional brands each year. As shown in Figure 1, the online attention of each regional brand is usually higher during weekdays with the highest level on Monday, a decline on Tuesday, slight fluctuation on Thursday and Friday and continuing to decline on Saturday and Sunday to reach the lowest level on Sunday. Such a trend is probably because most people work during the week and travel at the weekend. Thus, their online search behavior decreases, which leads to a decrease in online attention on regional apple brands.

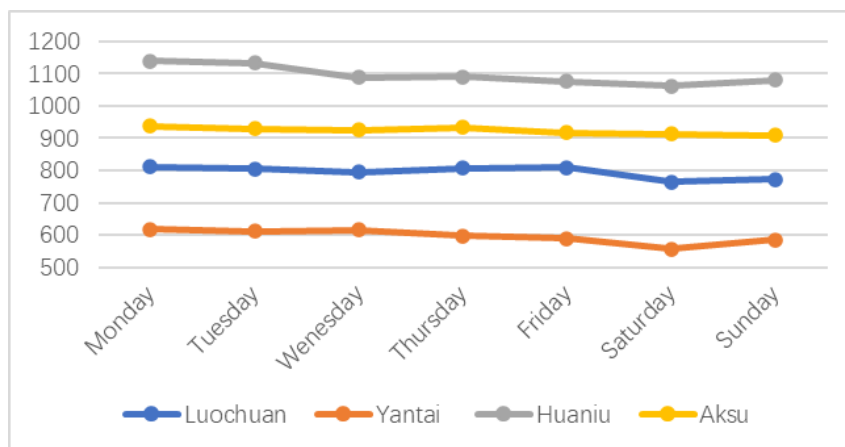


Figure 1: Weekly variation of online attention on four regional apple brands

Monthly variation analysis

The monthly average online attention of the four regional apple brands from 2013 to 2019 is shown in Figure 2. The results show that most online attention is from September to December every year, which is consistent with the time for apple picking and storage. From November to December and from January to February, Aksu apple receives the highest online attention. From March to October, Gansu apple's online attention is the highest, especially from September to October with the online attention being significantly higher than other regional apple brands. Yantai apple has the lowest online attention, which is similar to Luochuan apple which has a slightly higher monthly online attention figure than Yantai apple.

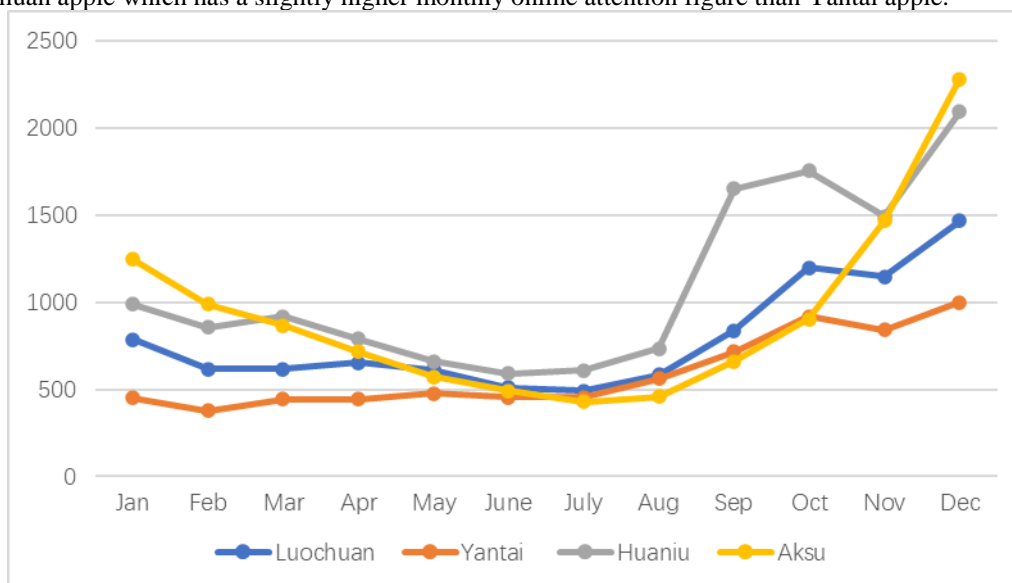
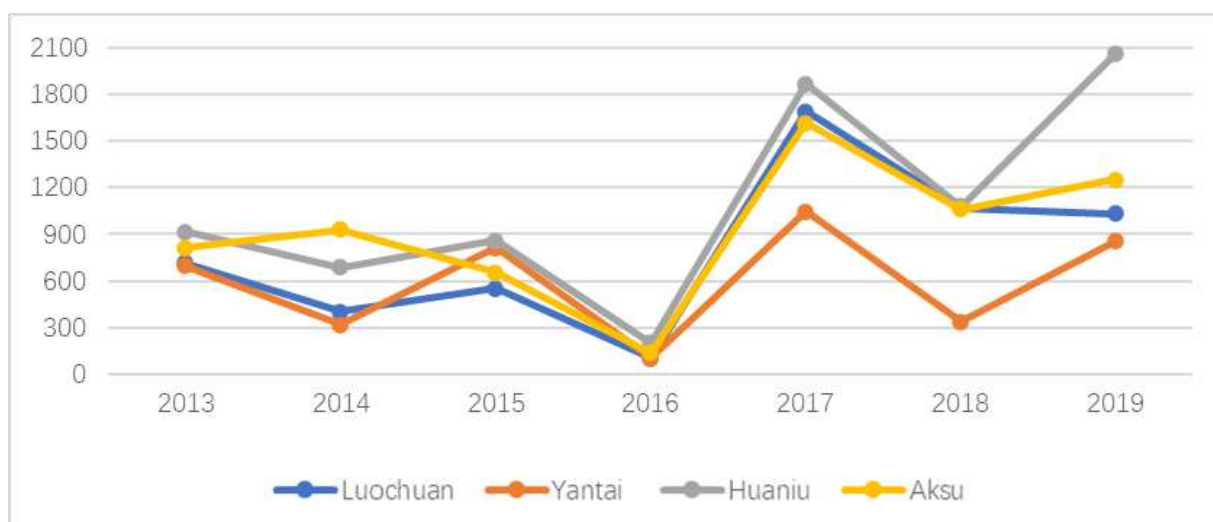


Figure 2: Monthly variation of online attention on four regional apple brands

Annual variation analysis

As shown in Figure 3, the annual online attention of Huaniu apple and Aksu apple is relatively high in general. Since 2017, online attention on Huaniu apple, Aksu apple and Luochuan Apple has significantly increased.



Spatial analysis of apple brands attention by regions

Regional differences

The Gini coefficient of Aksu apple is found to be the highest, while that of Huaniu apple is the lowest (see Table 1). High Gini coefficient indicates a great difference in online attention among provinces. It means that the online attention of a regional apple brand is mainly from netizens in one or a few provinces. In general, the inter-provincial Gini coefficient of each regional apple brand's online attention is high with a fluctuating growing trend. These results indicate that there is a large difference in inter-provincial online attention with a trend of gradual expansion.

Table 1. Gini coefficient of online attention on four regional apple brands

	Luochuan	Yantai	Huanu	Aksu
2013	0.3256	0.3836	0.4181	0.4287
2014	0.6361	0.5944	0.5971	0.7177
2015	0.9545	0.8375	0.8892	0.9460
2016	0.3792	0.5309	0.4435	0.4624
2017	0.3698	0.4265	0.3810	0.4455
2018	0.5750	0.4894	0.3974	0.5440
2019	0.5332	0.5846	0.5503	0.5514

Source: This study.

The Heffendal coefficients are found to be close to 0.1, with little difference between different regional apple brands' online attention (see Table 2). Thus, the concentration of attention on regional apple brands is low and relatively scattered.

Table 2. Heffendal coefficient of online attention on four regional apple brands

	Luochuan	Yantai	Huanu	Aksu
2013	0.0657	0.0647	0.0509	0.0541
2014	0.1307	0.1369	0.0947	0.0876
2015	0.1273	0.1151	0.0987	0.1280
2016	0.0472	0.2078	0.2711	0.0483
2017	0.0500	0.0693	0.0470	0.0491
2018	0.0742	0.0977	0.0887	0.0836
2019	0.0881	0.0926	0.0561	0.0669

Source: This study

National distribution of regional apple brands' online attention

This section used data from 27 provinces and 4 municipalities directly under the central government in the year 2019. The proportion of each province in the total search volume for each brand and the proportion of each regional apple brand in the total search volume for each province were analyzed and compared. The results are shown in Table 3. People from Beijing, Shandong, Guangdong, Zhejiang and Hubei pay high attention to the four regional apple brands. Luochuan apple receives the highest attention in Shaanxi, Ningxia and Guizhou. Yantai apple receives the highest attention only in Shandong. Huaniu apple has the highest attention in Gansu, Henan, Heilongjiang, Fujian, Qinghai and Tibet. Aksu apple has the highest attention in Xinjiang, Liaoning, Tianjin, Jilin, Shanghai and Hunan. From a regional perspective, the economy of provinces in eastern China is relatively more developed than other regions, which might lead to people's stronger willingness to consume apples. In

addition, in alignment with the law of distance decay, the closer the region is to the origin of a regional apple brand, the higher the online attention is on this regional apple brand.

Table 3. Provincial differences in online attention on four regional apple brands

Province	The proportion of each province in the total search volume of each regional apple brand				The proportion of each brand in the total search volume of the four regional apple brands in each province			
	Luochuan	Yantai	Huanui	Luochuan	Yantai	Huanui	Aksu	Luochuan
Shanghai	0.0468	0.0433	0.0344	0.0619	0.2356	0.1635	0.2388	0.3621
Yunnan	0.0173	0.0100	0.0147	0.0142	0.2812	0.1217	0.3292	0.2679
Inno Mogolia	0.0199	0.0143	0.0202	0.0177	0.2515	0.1353	0.3526	0.2607
Beijing	0.0831	0.0833	0.0739	0.0469	0.2752	0.2067	0.3377	0.1805
Jilin	0.0253	0.0157	0.0120	0.0301	0.2854	0.1326	0.1868	0.3953
Sichuan	0.0471	0.0334	0.0376	0.0256	0.3061	0.1627	0.3375	0.1937
Tianjin	0.0211	0.0312	0.0216	0.0424	0.1709	0.1892	0.2413	0.3987
Ningxia	0.0081	0.0020	0.0041	0.0029	0.4349	0.0819	0.3047	0.1784
Anhui	0.0312	0.0327	0.0363	0.0446	0.1977	0.1556	0.3176	0.3291
Shandong	0.0369	0.1592	0.0550	0.0579	0.1234	0.3987	0.2531	0.2248
Shanxi	0.0222	0.0282	0.0225	0.0085	0.2639	0.2506	0.3682	0.1172
Guangdong	0.0772	0.0742	0.0676	0.0752	0.2461	0.1776	0.2975	0.2788
Guangxi	0.0228	0.0221	0.0273	0.0337	0.1959	0.1427	0.3245	0.3369
Xinjiang	0.0048	0.0043	0.0161	0.0434	0.0593	0.0398	0.2753	0.6256
Jiangsu	0.0647	0.0778	0.0407	0.0652	0.2537	0.2289	0.2200	0.2974
Jiangxi	0.0220	0.0231	0.0260	0.0171	0.2312	0.1826	0.3770	0.2091
Hebei	0.0323	0.0471	0.0458	0.0394	0.1826	0.2002	0.3579	0.2593
Henan	0.0552	0.0252	0.0777	0.0309	0.2542	0.0872	0.4934	0.1652
Zhejiang	0.0621	0.0606	0.0549	0.0723	0.2323	0.1701	0.2835	0.3141
Hainan	0.0130	0.0044	0.0103	0.0078	0.3279	0.0829	0.3603	0.2289
Hubei	0.0434	0.0500	0.0460	0.0466	0.2186	0.1891	0.3195	0.2728
Hunan	0.0268	0.0236	0.0316	0.0427	0.1946	0.1286	0.3164	0.3604
Gansu	0.0115	0.0108	0.0537	0.0104	0.1090	0.0765	0.7005	0.1141
Fujian	0.0239	0.0246	0.0425	0.0381	0.1645	0.1272	0.4033	0.3049
Tibet	0.0008	0.0002	0.0006	0.0003	0.3612	0.0643	0.3944	0.1801
Guizhou	0.0177	0.0080	0.0087	0.0123	0.3551	0.1199	0.2397	0.2853
Niaoning	0.0265	0.0223	0.0241	0.0524	0.1931	0.1218	0.2416	0.4435
Chongqing	0.0256	0.0173	0.0154	0.0221	0.2994	0.1522	0.2478	0.3006
Shaanxi	0.0864	0.0341	0.0443	0.0151	0.4531	0.1342	0.3206	0.0921
Qinghai	0.0042	0.0011	0.0037	0.0025	0.3203	0.0628	0.3972	0.2197
Heilongjiang	0.0204	0.0159	0.0308	0.0198	0.2084	0.1222	0.4341	0.2352

Source: This study

Conclusion

People usually search for relevant information on goods in advance before making a purchase decision. To a certain extent, people's search behavior for regional apple brands on the Internet is representative of the popularity of a brand. Based on the Baidu search index, this study analyzes the spatiotemporal characteristics of online attention of four regional apple brands. The results show that regional apple brands' online attention is on the rise over time. In terms of weekly characteristics, the brands' online attention is high during weekdays and low during weekends, which is highly related to people's living and working habits. The monthly online attention shows a "U" shape with the peaks and troughs consistent with the seasonal characteristics of apple production. In addition, online brand attention of regional apples is unevenly distributed throughout the country, with more attention from provinces near each apple production region and economically developed provinces.

By analyzing the spatiotemporal characteristics of regional apple brands' online attention, this study provides a quantitative measurement of regional apple brands' popularity on the Internet. To promote a regional apple brand, future studies will be incorporating online celebrities on well-known platforms. In addition, further analysis can be made to investigate the spatial distribution of online brand attention of regional apples to find where most potential consumers are located. Finally, it is aimed

to target these regions and apply a series of marketing strategies to actively attract consumers and identify detailed factors influencing online brand attention.

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Research on technical analysis of basketball match based on data mining (Work-in-Progress)

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ABSTRACT

The aim of this paper is to preprocess basketball technology actions, to classify these actions with data mining technology, to mine association rules among them. The main works are shown below: The common approaches of data mining are discussed, such as preprocessing technology, classification technology, clustering technology and mining rules technology. Both ID3 decision tree classification algorithm association and Apriori association rules algorithm are studied in detail. The paper discusses basketball technology actions both on a small scale and a large scale, J48 decision tree classification and Apriori association rules mining algorithm basketball are applied, all these research results should have useful instruction to team.

Keywords: Data mining; Apriori algorithm; Basketball Skill.

INTRODUCTION

Basketball game is the use of basketball basic skills, according to a certain form of tactical organization, a process of offensive and defensive changes (Robertson, Back & Bartlett, 2016). In the game, the athlete is in the technical, tactical or position mobility performance for the complex, open, random and non-linear competitive ability to organize and game system, to show their resilience and technical level.

But it can also provide the basis for the coaches to instruct the tactics training and the on-the-spot technical and tactical contingency by analyzing the changing characteristics of the data (Shi, 2015). In actual combat, the active factor is the coaches should pay special attention to grasp the presentation of the performance of the spot when the game features, the use of tactics, staffing, time allocation and other parties have reference and guidance. Basketball statistics there are many, but how deep-level analysis of relatively messy, relatively complex statistical data, how to find these data changes, how to use these laws to solve some problems, targeted training and before and after the combination of tactics, Improve the ability of the game, basketball data analysis is an urgent need to solve the problem (Lazer, et al, 2014).

Data mining technology is undoubtedly the rise of technical and tactical analysis to provide a powerful help (Marmarinos, et al., 2016). Data mining technology is different from the traditional data statistical methods (Stein, et al., 2017). Statistics is a science of how to collect, organize, analyze and interpret digital information in data. Statistics can be divided into two broad categories: descriptive statistics and inferential statistics (Wang, 2014). Description Statistics involves organizing, accumulating, and delineating information in data; inferential statistics involves using sampled data to infer the population. Data mining is a kind of practical application algorithm (mostly machine learning algorithm), which can solve the problems related to various fields by using the data of each field (Zhang, 2014). Combining the frontier of informatics with the analysis of basketball technique and tactics, it can provide effective scientific basis for coaches and athletes in training methods inside and outside the field (Li, 2014).

THE VALUE OF DATA MINING IN BASKETBALL TECHNIQUE AND TACTICS ANALYSIS

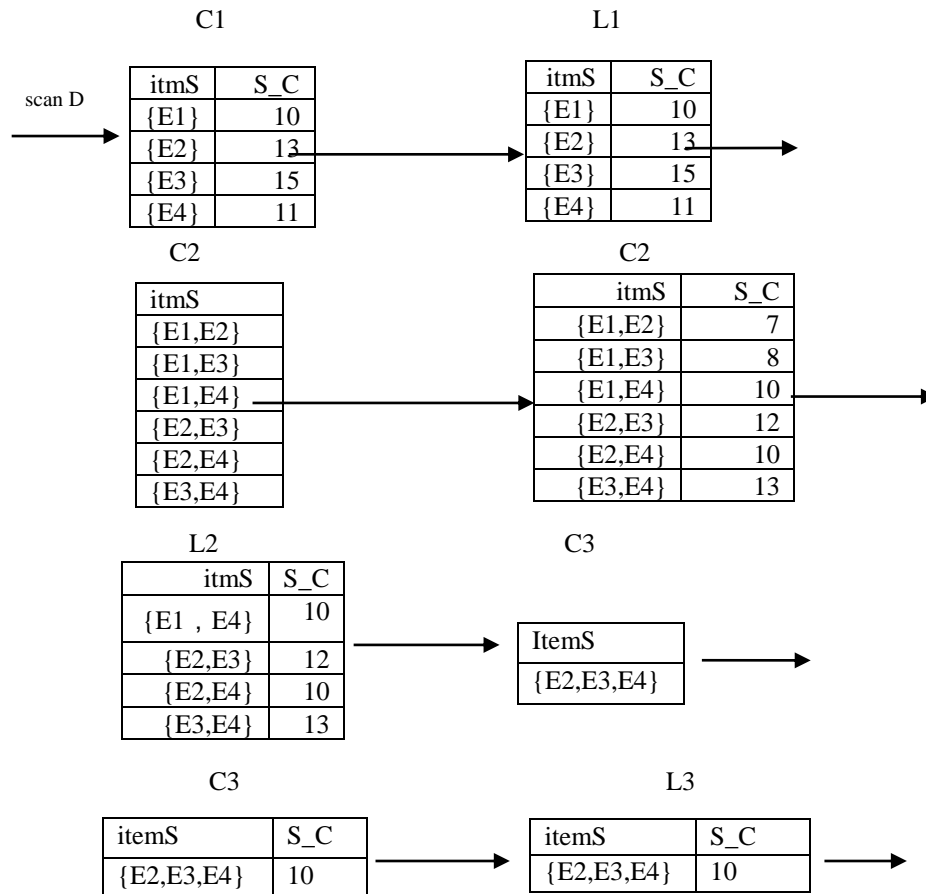
Data mining, as a discipline, is aimed at solving problems in various industries (Tashakkori et al, 2014). Different technologies and practices in different research fields are needed in the process of data mining. Data mining technology in has such a definition: from a large number of incomplete, noisy, fuzzy, random application of actual data, extract hidden in it, people do not know in advance, but it is Potentially useful information and knowledge on the process side (Martinez & Walton, 2014). It takes a global solution and applies it to the development of technical and tactical combinations to solve the same underlying problem.

For example, in a basketball game, there are breakthroughs in basketball players, shooting, passing, assists, break points, shooting, shooting, errors, but also including its shooting rate, free throw percentage, Ball hits, and so deep technical statistical analysis, as well as without the ball cover athletes with mobile, rebounds, mistakes, steals, blocks, effective defense, fouls and their nature, as long as the technical and tactical action can be defined, are The object of data mining. Through the computer software recording or video analysis, access to technical and tactical statistics, find the average and limit values, resulting in frequent itemsets and a number of association rules (Monroe, et al, 2013).

Basketball match between the players in the group and the pairing relationship between the pairing are always very complex and changeable. In the past five years, there are more and more interdisciplinary researches on the combination of physical education, sports training and data mining, such as the application of data mining algorithms in technical and tactical analysis of volleyball, table tennis and cricket (Shimizu, Louzada & Suzuki, 2014). The correlations between variables are determined by finding the correlation coefficient among the variables, and frequent itemset pattern knowledge is found from the given data set. Data mining is to analyze each data and find the regularity from a large amount of data. There are three steps (z): data preparation, regular search and regular expression. After obtaining the game data, how to do a good job of data mining depends on whether you can find the appropriate law.

ASSOCIATION RULE MINING BASED ON APRIORI ALGORITHM

Association rule mining is a way to find out the meaningful relationship between many data. In this study, the purpose of mining association rules is to find the implicit association in the database of basketball technology action. Apriori algorithm is the most widely used method of association rule mining. It is an algorithm to find frequent itemsets by using candidate itemsets. The following is based on the design of basketball scripting language on the basis of the analysis of the Apriori algorithm in the excavation of basketball action association rules in the design and application (Rehman & Saba,2014). Apriori algorithm is a typical algorithm to find frequent itemsets in transaction database. Frequent itemsets are the itemsets with support \geq minimum support (Cheng et al, 2016). Achieve this goal, anti-corruption scanning is needed for the database of things. This step wastes more time, restricting the operation of Apriori algorithm. Apriori algorithm can be recursive way, the transaction database to find out all the frequent itemsets. Specific operation is the first thing in the data table as a candidate for each item set, with C_m to represent (m value can be 1 , 2 , 3.....), then the basketball technical action database The item sets with support \geq minimum support are set as the set of frequent 1-itemsets, which can be expressed as L_m (the value of m can be 1 , 2 , 3.....), and so on, until L is empty, the algorithm stops (Brooks, Kerr & Guttag, 2016).



APPLICATION AND ANALYSIS OF DATA ACQUISITION AND PRETREATMENT OF BASKETBALL TECHNIQUE

Data Collection

Basketball is a high-profile, participatory sport. With the development of communication technology, satellite broadcast, TV broadcast and broadband network, can be far away thousands of miles of basketball game screen instantly spread to millions of households. People through the camera, broadband network to record the game scene, and then burned into a CD-ROM burner. In this paper, the original data is to live through the broadband network broadcast NBA (National Basketball Association) basketball game scene saved to the hard disk, but also the various sites on the game data is also copied down; and then the game video Burner burned into VCD discs; the last by repeated viewing the game for manual statistics, combined with the major sites of data collection.

NBA League regulations, a total of 48 minutes a match, divided into 4 sections, each 12 minutes, each round of the attack to be completed within 24 seconds, a match 100 to 200 rounds, if more than 24 seconds, then team will lose the ball. If the players have a good grasp of technical action, good coordination between the players, then it can be completed within 24 seconds, on the contrary, it will lose time because of shooting opportunities. Therefore, in this statistical analysis, we have an offensive round for the time period, statistics of a basketball game 5, 20, 100 round of the general technical action (such as Table 1).

Table1: statistics of general technical action

Round	Basketball technical action
R5	Rebounds, Pick-and-roll, Dribbling, Dribbling, Passing, Pick-and-roll, 2-points
R500	Dribbling, Dribbling, Assists, Pick-and-roll, 3-points
R100	Fast break, long pass, Technical foul, Steals, penalty

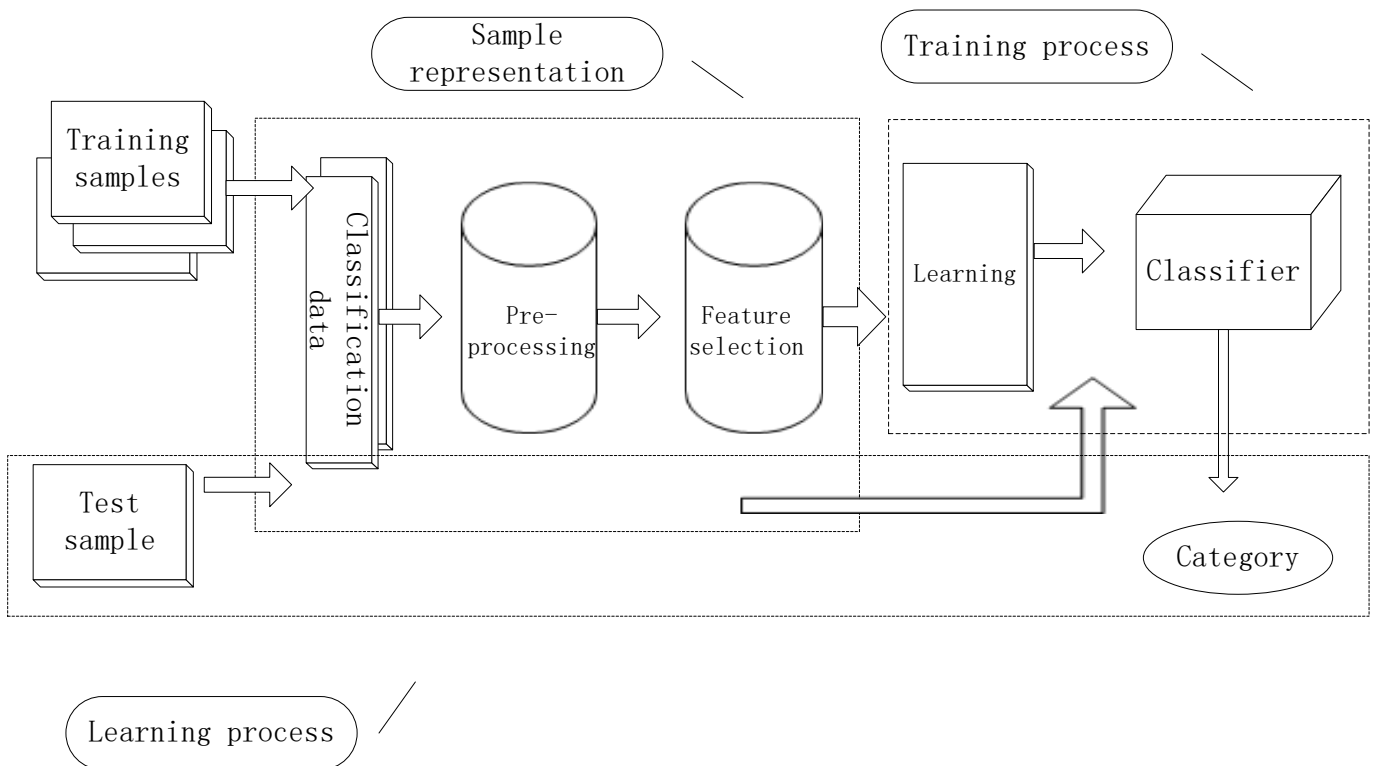


Figure2: The machine learning process of classification

Data Cleansing And Integration

Incomplete and inconsistent data can be used to fill the vacancy value, to correct data inconsistencies.

(1) Fill the vacancy value for no data items, according to the meaning of the data item, define a default value, and then use it to replace the missing vacancy value.

For example, T8 this round, "dribble" and "ball" is the same technical action, should be consistent, are corrected to "dribble", and so on.

(2) To correct inconsistencies in data collection Sometimes there are inconsistent data (what is the data inconsistency? Such as "dribbling" and "ball driving", both of them are the same technical action, they are inconsistent). There is a certain correlation between some data, A, B correlation can be measured by the following formula:

$$r_{A,B} = \frac{\sum(A - \bar{A})(B - \bar{B})}{(n - 1)(\delta_A \delta_B)}$$

$$\bar{A} = \frac{\sum A}{n}, \bar{B} = \frac{\sum B}{n}, \delta_A = \sqrt{\frac{\sum(A - \bar{A})^2}{n - 1}}, \delta_B = \sqrt{\frac{\sum(B - \bar{B})^2}{n - 1}}$$

where, ; r > 0, A and B are positively correlated; r = 0, A and B independent, irrelevant; r < 0, A and B negative correlation. The correction method is:

If action = "ball forward"
Then action = "dribble"

If action = "2 points into the ball"
 Then action - "2 points goal"

Data Integration

Multiple data sets are stored together in a consistent data store. There are data on the network and the data manually recorded by the video, now to be combined storage, storage before the merger with a technical action data. There are several "dribbling" actions, where they can be combined into one. The same "pick and roll" is also appeared several times, also merged into one. See Table 2.

Table2:NBA Technology Actions Statistics

Tid	Basketball technical action
T8	Rebounds, ?, Dribbling,?, Passing, ?, ?, 2-points
T15	?, Passing, ?, Assists, ?, ?, 3-points
T102	?, Steals, ?, Long Pass, ?, Fast break, ?

Data Reduction

Complex data analysis and mining on large amounts of data will take a long time to make this analysis impractical and unnecessary. What is the data reduction?

Heap reduction redundancy deleted the value. 9 technical moves, including: assists, 2 points, rebound, steal, and other steals in the game, such as "dribbling", "passing" 3 points, 3 free throws, cloak, break and block o Data compression using nine letters A, B, C, D, E, F, G, H, I will be the 9 kinds of technical actions to encode, compress the data set. A represents assists, B represents 2 points, C represents rebounds, D stands for steals, E for 3 points, F for free throws, , G for pick and roll (Clk), H for break (Brk) and I for cap (Blk).

In this study, we use WEKA mining software, in order to more convenient basketball data mining, the need for the relevant format conversion, based on the previous step, one after the corresponding if there is action, then use y to represent, if No action, then use n to represent, see table 3.

Table3: Basketball technology action Judgment

Round	Basketball technology action
R5	y, n, n, n, n, y, y, n
R20	n, n, y, n, n, y, n, n, y
R100	n, n, n, n, n, n, y, n, y

Finally, the data storage file format to be converted to WEKA mining software identified (Attribute Format File) format to save. This only needs to paste the statistical table to WordPad, and then add arff file required attribute header @ attribute, and the file header with @ relation, data with @ data. As shown below:

```
@relation Basketball technology
@attribute Tid{ T8, T15, T102, ... }
@attribute A{ yes, no }
@attribute B{ yes, no }
@attribute C{ yes, no }
@attribute D{ yes, no }
@attribute E{ yes, no }
@attribute F{ yes, no }
@attribute G{ yes, no }
@attribute H{ yes, no }
@attribute I{ yes, no }
@data
TB, no, yes, yes, no, no, no, no, yes, no
T 15, ye s, no, no, no, yes, no, no, yes, no
T 102, no, no, no, yes, no, no, no, no, no
```

Figure3:Arff format of basketball technology actions statistics

EMPIRICAL ANALYSIS

Frequently frequent 1 -phase set L1: B, C, F, G, H; behind the number of support count or call frequency;

Frequent 2-phase sets L2: AB, AC, BC, BF, CH;

Frequent 3-itemsets L3: ABC;

Experiment Parameters: Selects the default setting except the minimum support and minimum confidence and the number of output rules. Also change the output of frequent itemsets from false to true.

Experiment parameters: delta = 0.05, minimum support 0.6, minimum confidence 0.4, the number of output rules 30, significant degree -1.0 If changes in parameters, such as change Minimum support, minimum confidence, the number of output rules, the degree of salience can be other experimental results.

When the data volume is large, the mining algorithm based on the analysis of Chapter 4 can also mine many association rules. Such as the NBA (American Basketball Association) League 2010-2011 season part of the game's basketball action using Apriori algorithm mining results are as follows (Figure 4).

```

Scheme: Weka association Apriori
Instances:261
Attributes:10
  Tid
  A
  B
  C
  D
  E
  F
  G
  H
  I
Associator model (full training set)
Minnum support:0.6(157 instances)
Minnum metric(confidence):0.4
  Number of circles performs:8
  Generated sets of large itemsets:
  Size of set of large itemsets L(1):7
  Large itemsets L(1)
  A=no 203
  D=no 202
  E=no 230
  F=no 210
  C=no 159
  H=no 161
  I=no 242
  Size of set of large itermes L(2):9
  Large iterms L(2)
  A=no D=no 166
  A=no E=no 192
  A=no I=no 188
  D=no E=no 173
  D=no F=no 163
  D=no I=no 185
  E=no F=no 179
  E=no I=no 215
  F=no I=no 191
  Size of set of large itermes L3:3
  Large iterms L3:
  A=no E=no I=no 177
  D=no E=no I=no 160
  E=no F=no I=no 164
    
```

Figure4:The result of Apriori arithmetic algorithm association rules

Experimental parameters: In addition to the Minimum Support and Minimum confidence and the number of output rules other than the default settings. In addition, the output of frequent itemsets is changed from false to true. delata, Minimum support, Minmetric 0.4, numrules of output rules 30, singnificance level -1.0 . If you change the parameters, such as changing the minimum support, minimum confidence, the number of output rules, salience, etc. can be other experimental results.

Rule 1 shows that there is no 3-point goal in the absence of assists, with a 95% confidence level. Rule 2 indicates that no assists and no blocks will result in a 94% confidence goal. From which to see how important assists. You can also find other useful rules. Of course, with some useless rules, such as Rule 3: No 3 goals without blocks, confidence 94%, this rule has no practical significance for players and coaches. Useful rules can be used to guide team training, such as multi-point break in the ball to the three-point unguarded players, so that they vote for three points.

CONCLUSION

Although there are studies on the physical effects of basketball on college students, the theoretical research on the sustainable development of basketball, the impact of mass media on the development of CBA league and the key of basketball video analysis Technology research, etc., but both at domestic and foreign, the basketball technology movement mining research is almost zero, there is no ready-made results of the case.

In this paper, based on the analysis of application and analysis of data acquisition and preprocessing of basketball technical movement, this paper studies the application of data mining technology in basketball technical movement through the association rule mining method based on Apriori algorithm. The creative combination of movement and computer technology opens the way for the study of the law of basketball technology movement, and provides more accurate learning resources for coaches and athletes.

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RFID and environmental sustainability: Case of Weatherford firm in the oil and gas drilling industry

(Work-in-Progress)

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ABSTRACT

This paper features a one-case study analysis focusing on Weatherford, an oil and gas exploration firm operating in 75 countries and the firm's use of radio frequency identification (RFID) for its TRIP1 system used to direct the work of function tools downhole in a well reservoir. Two theoretical frameworks, the Socio-Technical Systems Theory and the Affordances Theory are used to interpret Weatherford's RFID deployment in this one specific application. This study uses the qualitative case study method and content analysis in evaluating the primary data. The importance of RFID specifically for applications in the oil and gas exploration industry ties in directly with the current urgent concern of society for environmental sustainability.

Keywords: Radio frequency identification (RFID), environmental sustainability, oil and gas drilling, sensors, environmental threats..

INTRODUCTION

Today's concern for environmental sustainability warrants the investigation of modern technologies that can help especially in the oil and gas drilling industry, one with a direct significant impact on society's energy consumption. Radio frequency identification (RFID) is one such technology and its application in Weatherford is examined in this one-case study paper. Operating in 75 countries, Weatherford delivers innovative energy services undertakes both deep water and onshore oil and gas exploration projects worldwide. Two theoretical frameworks, the Socio-Technical Systems Theory and Affordances Theory, are used to understand this firm's RFID system deployment in its TRIP1 system.

LITERATURE REVIEW

This section will cover a discussion of the basics of RFID systems, the use of RFID in the oil and gas drilling industry, the Socio-Technical Systems Theory, Affordances Theory, and Weatherford firm background.

Radio Frequency Identification (RFID) System Basics

Radio frequency identification (RFID) consists of the tag and the reader (Felemban & Sheikh, 2013). Information is usually embedded on the tags which is, then, detected by the reader, which subsequently transfers the data to any business software application in a firm's legacy system. RFID tags could be either active or passive. The RFID reader transmits a radio frequency interrogation signal while scanning the tags. When this signal is received by the RFID tag, it responds by transmitting the information embedded in it. One of the key benefits of using RFID tags is that having "line of sight" access to the tag is not required in order for the data to be accessed or read by the RFID reader. This means significantly more RFID tags can be read by the readers as they pass through warehouse portals, for instance. This is the limitation of the older technology --- the bar code, which the RFID tag has eventually replaced.

RFID System Use in the Oil and Gas Drilling Industry

RFID systems have been used for various purposes in the oil and gas drilling industry (Roberti, RFID Journal, no date). The following are selected examples of RFID system use in the industry by different firms and government agencies. British Petroleum (BP) uses both RFID and global positioning systems (GPS) to track material components intended for building exploration platforms shipped from its European warehouses to the Hyundai Heavy Industries warehouses in South Korea. In Australia, Bechtel used an RFID-based materials management system in the construction of three liquefied natural gas and export facilities in Curtis Island. An RFID-based system consisting of tags, readers, vehicle readers, and handheld interrogators was used by JV Driver Group in automating the monitoring of materials used in its construction projects in Canada. JV Driver Group is involved in construction services for the oil and gas, energy, petrochemical industries. Sempra Energy uses RFID for customer billing resulting in time savings gained from avoiding waste involved in monitoring unrecorded gas meters installed in the premises of about 3,000 Southern California Gas customers. Sempra Energy covers both Southern California Gas and San Diego Gas and Electric. The Argonne National Laboratory of the U.S. Department of Energy uses RFID to track and report on the status of barrels of nuclear materials held in the department's storage facilities.

Socio-Technical Systems Theory

Bostrom and Heinen (1977) presented the socio-technical systems (STS) theory which analyzes an organization's information system using the components of a work system proffered by Leavitt (1965). The socio-technical model proposed by Leavitt uses the following dimensions of organizational work systems as tools of analysis: task, structure, people, and technology. Piccoli (2008) broke down the "technology" dimension by referring to depicting it as an integrated set of software that transfer, compute, and record information.

Two subsystems constitute the STS system: (1) the tasks and technologies that make up the technical subsystem transform inputs into outputs; and (2) individuals in a work unit, their relationships, reward systems, and authority and work structures make up the social subsystem. Organizational systems usually set goals instigated by pressures from the external environment. The organization's internal environment consisting of both the technical and social subsystems, consequently, need to interact optimally to meet organizational goals in response to external pressures. The STS framework is another theoretical lens that can assist in analyzing an organization's experience in deploying a new information systems application using specific information technologies. The STS framework has been helpful in providing descriptive narratives supporting the different STS dimensions, but, at the same time, it has been remiss in accounting for the interactions of these dimensions in explaining their potential to change the organization. Thus, this case study uses the "affordances theory" (Gibson, 1986, 1977) and very specifically, the concept of "functional affordances" (Markus & Silver, 2008). These complementary theoretical lenses will bridge the missing gap and assist in showing how information systems relate to behavioral routines of end workers as manifested in their work practices (Leonardi, 2011) as they try to realize their action goals (Markus & Silver, 2008).

Affordances Theory

The word "affordance" used in information systems theory discussions was first derived from the domain of ecological psychology when Gibson (1986, 1977) used it to characterize how material objects offer both potential uses and constraints to actors or end users. Material properties of information systems allow "possibilities for goal-oriented action" or "functional affordances" of that form of technology (Markus & Silver, 2008). Chemero (2003) suggests, though, that affordances have to be perceived by the end user before they can be actualized. The term "functional affordances" refers to capabilities enabled by given forms of information systems or information technologies. The end user's ingenuity, the form of information system or technology, and the requirements of the organizational context all determine an end user's ability to extract certain "functional affordances" from the technology used (Leonardi, 2011).

Features of different forms of information technology can be used by human agents or ignored by them, depending their end purposes (Stinchcombe, 1968). Thus, both intended and unintended consequences of information technology are realized through functionalities of material artifacts that "afford" those consequences.

Weatherford Firm Background

Weatherford is a leading oil and gas exploration firm, present in 75 countries, operating in more than 350 locations, and avails of the services of 17,000 world class experts in exploration. It is dedicated to developing innovative energy solutions designed to be environmentally and economically sustainable (Weatherford, 2021b). Its key energy transition offerings are: (1) geothermal energy services; (2) carbon capture, utilization, and storage (CCUS); and (3) plug and abandonment services (Weatherford, 2021a). Its main range of services and products cover: (1) formation evaluation: the firm helps customers collect, interpret, and apply formation evaluation data to locate the optimal formation target; (2) drilling: Weatherford offers careful planning, expert engineering, and drilling technologies to help customers maximize drilling exposure; (3) completions: the firm offers modern completion technologies (i.e., completion means opening up a reservoir for production) to reduce risks, minimize costs, and optimize production for any completion; (4) the firm uses a strategy to ensure that the customers use innovative field management solutions to produce more hydrocarbons at the lowest costs (Weatherford, 2021b).

RESEARCH METHOD

This study uses the case study and content analysis methods in aligning the concepts prescribed by the two theoretical frameworks to the Weatherford RFID system. The primary data used was the transcription of the conference presentation talk of Euan Murdoch, RFID Completions Product Line Manager, Weatherford at the RFID Journal Live! Annual Conference and Exhibition, on September 26-28, 2021, Phoenix Convention Center, Phoenix, Arizona, USA. In addition, secondary data sources from academic and trade articles were content analyzed using key concepts in the frameworks. The following are accepted definitions of the content analysis:

Content analysis is any research technique for making inferences by systematically and objectively identifying specified characteristics within text. (Stone et al., 1966, p. 5)

Content analysis is a research technique for making replicable and valid inferences from data to their context. (Krippendorff, 1980, p. 21)

Content analysis is a research method that uses a set of procedures to make valid inferences from text. (Weber, 1990, p. 1)

The concepts used for content analysis were derived from the two theoretical frameworks that also formed the "context" of this study:

A context is always someone's construction, the conceptual environment of a text, the situation in which it plays a role. In a content analysis, the context explains what the analyst does with the texts; it could be considered the analyst's best hypothesis for how the texts came to be, what they mean, what they can tell or do. In the course of a content analysis, the context embraces all the knowledge that the analyst applies to given texts, whether in the form of scientific theories, plausibly argued propositions, empirical evidence, grounded intuitions, or knowledge of reading habits.... The context specifies the world in which texts can be related to the analyst's research questions. (Krippendorff, 2004, p. 33)

The primary and secondary data was analyzed within the context provided by the two frameworks, which are considered the “prior theory.” “Analytical constructs operationalize what the content analyst knows about the context, specifically the network of correlations that are assumed to explain how available text are connected to the possible answers to the analyst’s questions and the conditions under which these correlations could change....analytical constructs ensure that an analysis of given texts models the texts’ context of use...” (Krippendorff, 2004, p. 34).

Following the methodological prescription of Krippendorff (2004), the content analysis procedure deployed in this study ensured that the following steps were performed. The focus was kept on the research question, which guided the entire inquiry. The key concepts covered by the socio-technical and functional affordances theories were used to identify relevant text materials in the primary and secondary data sources for analysis. Interpretations of the application of these theoretical concepts in the data sources were made within relevant contexts. Explanations made sought to operationalize the analytical concepts sought to be illustrated within the firm’s experience. Inferences were made within the boundaries of the two theoretical frameworks used as answers to the key research question were sought.

STUDY FINDINGS

The following are the findings for Weatherford applying the two theoretical frameworks.

Socio-Technical Systems Theory

Social subsystem

Weatherford has a tight system where it supports environmental protection from the top down --- from statements of its corporate strategic commitments to cultural values it espouses, the nature of the products and services it offers its corporate customers, and human resources policies it has implemented (Weatherford, 2021a). Commitment to environmental protection is a critical goal on account of the type of services the firm provides, which pose direct threats to the state of the environment wherever the oil and/or gas exploration is taking place geographically. This is also one of the “four tenets” the firm espouses: waste management; water management; reduced impacts to land; and energy management.

In training its workforce, Weatherford puts a strong emphasis on teamwork and collaboration as these directly impact the firm’s ability to undertake risky exploration projects on land or on deep water. Active employee engagement in company tasks and activities is gained through virtual townhalls, employee surveys, small group discussions, and site visits (Weatherford, 2021a).

Weatherford also encourages the development of creative engineering talents of its workforce, and count on its workers as key sources of innovative ideas needed to gain the edge brought forth by digital transformation and technological innovation (Weatherford, 2021a).

Weatherford’s Board of Directors also has the Safety, Environment, and Sustainability Committee. One of the standards upheld by this committee is the “Operational Risk Management Standard” that stipulates all risk assessment requirements and responsibilities for all drilling and exploration geographical sites using the firm’s products and services (Weatherford, 2021b).

Technical subsystem of Weatherford

Background Information on Oil and Gas Drilling and Exploration

The RFID system in this case study involves an application in oil and gas drilling and exploration, specifically the “upstream” sector of the industry. The following activities are involved in the “upstream” sector: exploring for oil and gas fields, drilling oil wells, and if hydrocarbons are located, digging wells to enable crude oil or natural gas to emerge from the depths of the earth (Stengel, 2014).

Before work can begin, engineers need to identify potential sources of hydrocarbons. The two methods commonly used are the geological and geophysical methods. The geological method involves using surveys for field mapping or aerial/satellite imagery to peer “within” the depths of the earth. On the other hand, the geophysical method uses seismic reflection using refraction, magnetic, gravity, or electromagnetic fields. Weatherford specifically uses seismic methods which depend on sound waves that are sent into the depths of the earth and which are reflected and refracted off the subsurface strata to be received by seismic receivers. Data gathered by these receivers such as arrival times of sound waves, amplitude variations and frequency reveal potential oil gas deposits.

The Weatherford case study detailed here involves deepwater hydrocarbon exploration. Offshore drilling usually uses a mobile offshore drilling unit or (MODU). The MODU is designed taking into consideration the following: “... ocean depth, seabed geography, average wind speed, average wave height, currents, environmental concerns, and cost...” (Stengel, 2014). Such a structure is usually the focus of serious environmental concerns and thus, whatever means can be deployed to lower the potential damage to the environment warrants serious considerations. The RFID system that will be described here contributes to ameliorating such concerns.

A major operation conducted when drilling the well has commenced is using a drill pipe that is fed down a borehole. Within this drill pipe, drilling fluid or mud is made to flow down this pipe and back up to surface to balance the underground

hydrostatic pressure, cool the bit, and flush out stray rock cuttings that could hamper future work in the hole (Miesner & Leffler, 2006).

Engineers try to prevent and/or prepare for what is called “uncontrolled blowout” in such drilling holes. One way to do so is to use blowout preventers fitted at the borehole opening. A blowout preventer is used to seal a well and consists of hydraulically actuated steel rams that close around the drill string or casing (Miesner & Leffler, 2006). Equipment that collect data on pressures, rock types, permeability, porosity, and other subsurface attributes is put down the open hole before steel casing or a series of steel pipes are installed in layers to stabilize the well (Stengel, 2014).

The borehole is created in sections and once the process is completed, the steel casing is inserted into the hole and firmly cemented into place in order to seal off the area from water and contaminants. More importantly, it will prevent oil from leaching into the adjacent groundwater.

If the data gathered by the equipment positively indicates the presence of hydrocarbons, additional tests will be done to determine flow rates and formation pressure (Stengel, 2014). There are usually two anticipated outcomes: either there are commercially viable quantities of hydrocarbons in certain locations, or there are none. If the outcome is positive, a well-head valve assembly is installed on site, and appraisal wells are drilled to more precisely determine the amount of hydrocarbons present. If, on the other hand, there is not enough hydrocarbons found, it is simply sealed with cement plugs to avoid wellbore fluids from surfacing (Stengel, 2014).

If the tests firmly establish the presence of commercial volumes of hydrocarbons, the “development” phase of the oil exploration is poised to begin. At this stage, the development wells are built to draw out the hydrocarbons. The size of the reservoir, subsurface geology, surface geography, access, and the corporate budget will determine how many wells will be developed (Stengel, 2014).

Weatherford’s TRIP1 System described in this case study is involved mainly in this “upstream” phase of oil and gas exploration. The TRIP 1 System uses RFID, after 10 years of development, in this manner: RFID tags contain content that direct the way tools should function downhole, or at the bottom surface of a well operation (Murdoch, 2021). Thus, the firm uses the RFID tags as a way to communicate with the tools already placed downhole. Tools are outfitted with RFID readers, which are powered up by batteries which are also brought downhole. These tools help to physically move or to do specific tasks as directed by the instructions encoded on the RFID tags. Examples of instructions might include --- the tag may tell a tool to open or close a valve, or to perform a specific task. Once the appropriate instructions are encoded in the RFID tags, these are dropped into a well being explored. These RFID tags are pumped down the tube, down to the well. The RFID readers on the tools, in turn, interrogate the tags once they are in contact with them. The tools determine if the tags are relaying instructions meant for them (Murdoch, 2021).

Engineering Challenges with RFID

Weatherford did its due diligence and tried to find a technology solution in the marketplace that would meet its needs (Murdoch, 2021). In the absence of a solution, their tech people found ways to enable to use RFID tags with temperatures of 450 degrees Centigrade and with pressures of up to 30,000 PSI (pounds force per square inch of area). An atmospheric chamber is used to house the RFID tags, antennas, and auxiliary equipment in order to protect them from the force of 30,000 PSI.

The second challenge is the limited space envelope available for the work. Once drilling reaches the bottom of a hole, there are only about 8 inches a hole, about eight inches across to work with. Meanwhile, there remains the need to transport the RFID tags to that location. The environment at those depths can also be very harsh --- with the presence of hydrogen sulfide, high levels of carbon dioxide, high temperatures, high pressure levels, and high levels of erosion. All these conditions pose a challenge for how the tool needs to be designed. As it is, there is only a very thin section available for getting the hydrocarbons back up the insides of these tools. Also, with the limited space available, engineers have only about one to two inches to play with in the wall section of the tube within which to pack all the electronics required.

Considering all these challenges in the drilling hole, Weatherford did try different technology solutions to deal with the given conditions (Murdoch, 2021). The firm chose to use a low frequency based system since the elements involved will be enclosed in fluid. The technology people also looked at FM and AM systems and compared their performance. They needed a solution with a read/write system that would allow the engineers to write entire instructions in the form of codes and embed them in the RFID tags.

Weatherford had to choose between an AM or FM system to do the job (Murdoch, 2021). The first system they chose was an AM system for a small metal conduit that had a coil antenna wrapped around it and was used to pump RFID tags downhole. It turned out that very few applications could really use this his AM system. Eventually, the technical team decided to work with an FM system that uses an off-the-shelf 23 millimeter glass encapsulated RFID tag that is mounted on or press fitted into a silicon carrier. Apparently, this set up gives the technical team the ability to carry the RFID tags into the fluid flow and stabilize them as they pass through the antenna. These glass-encapsulated RFID tags can be heated up to 80 to 90 degrees

centigrade, but surrounding temperatures in the hole could go as high as 100 to 150 centigrade. Thus, to cope with these higher temperatures, a temperature screening system had to be created to protect the tags. The work also usually entails working only with hundreds of tags annually, rather than thousands of such tags. This works out well for the need to screen the RFID tags in order to survive given temperatures. When the temperature and pressure levels in the well get high, RFID tags are repackaged in containers with formal plastic coating. This will allow the RFID tags to withstand pressures of up to 25,000 PSI.

Among the mechanical challenges involved is designing the antenna system (Murdoch, 2021). It is important to make sure that the antennas are reasonably separated from metallic components of the system. This is one of the weaknesses of RFID systems --- they do not work well when adjacent to metallic elements. A rugged antenna design is used to ensure that RFID tags could withstand high vibration, high erosion, and high speeds of about 10 to 40 barrels per minute at which they will be pumped through the pipes. This works out to a velocity of about 8 to 13 meters a second. The antenna design involves the use of a double helix wound antenna which uses the PEEK plastic, which is known for its exceptional qualities:

- “...
 • Resistance to harsh chemical and corrosive environments, including hydrogen sulfide at elevated temperatures
 • Superb hydrolysis resistance with high retention levels of mechanical properties after prolonged exposure to steam or sea water at elevated temperatures
 • Broad operational temperature range
 • Low levels of creep and excellent mechanical properties, which can be further enhanced by the addition of fillers such as glass and carbon fibers
 • Abrasion and wear resistance under high loads (bearing grades)...” (www.curbellplastics.com, 2022)

A major technical challenge for Weatherford at this time is vastly improving the use of RFID tags downhole so they could be retrieved up to the land surface safely. At the moment, the tags have software code designed to direct the work of tools at the bottom of the well (Murdoch, 2021). But it is also critical to be able to use the tags to gather key data underground during the exploration process from accelerometers, pressure transducers, and other devices used. Data on pressure, temperature, torque, rate of penetration, etc., are only some of the data pieces that can be captured and analyzed using data mining algorithms to both solve operational problems and model improved future drilling activities (Greengard, 2013, August 19).

Types of Tool Activation Method Used by Weatherford

The first method used is the single cycle method wherein RFID tags are pumped down to the tools at the bottom of the well (Murdoch, 2021). The tools, then, register the tags and associates the tag that is supposed to work with a specific tool. Now, there is usually high pressure at the well bore, which is usually stopped from getting in by a piston. When a specific tool has to be used and is needed to function, a heater element is heated up by the tool's electronics; the heat emitted, then, melts the headlock core which allows the piston to pop up. The resulting pressure, then, able to transfer this hole to a bigger piston. As that fills up, it creates a force, slides a sleeve, and opens a valve to allow fluid to come through. All this work can only be done once with the single cycle method.

The next kind of method involves the use of pump-based tools. If the work requires opening and closing things repeatedly, then, a micro pump housed in a tool is needed to generate its own pressure in the tool.

The TRIP1 System was first successfully implemented in Nigeria, in one of its offshore fields, in about 1,015 meters of water depth (Murdoch, 2021). The project team took 60 percent less time in completing the work with 50 percent less workers. Also, the team estimated work completion with 70 percent less carbon dioxide emission with the use of the RFID system.

Affordances Theory

Strong et al. (2014) posit that the affordance theory has not really clarified how an affordance's potential is actualized, how affordances operate within an organizational context, and how affordances arise as a “bundle” of interrelated affordances. Strong et al. (2014) also developed the concept of “organizational affordances.” In the framework of Strong et al. (2014), actions of organizational end users affected by the same information system or technology need to coalesce in such a way as to obtain desired organizational-level immediate outcomes. These, in turn, will eventually lead to the actualization of organizational level goals. Both outcomes and goals relate to “organizational affordances” end users intend to actualize. So, for instance, the functionality of the organizational affordance called “enabling intervention completion installation affordance” only materializes if the workers and engineers in the hydrocarbon exploration site properly deploy RFID tags so that they work with the function tools as intended. This requires the application of the right technical skills to ensure that the appropriate instructions are encoded in the RFID tags and that they will properly be read by the RFID readers associated with the relevant function tools downhole.

IT-related affordances are defined by Markus and Silver (2008, p. 622) as “... the possibilities for goal-oriented action afforded to specified user groups by technical objects...” These IT-related affordances are also called “functional affordance” in the context of this study. Zammuto et al. (2007) has a related “take’ on this and calls attention to affordances that arise from the interaction of organizational systems and different forms of information technology. Technology is not viewed as being “static” --- rather, it evolves through time, especially when implemented and used by individuals in an organizational context and “interpret” it during its use.

Actualization of affordances consists of "...the actions taken by actors as they take advantage of one or more affordances through their use of the technology to achieve immediate concrete outcomes in support of organizational goals..." (Strong et al., 2014, p. 70). In order to move from being an "affordance potential" to being an "actualized affordance," there are certain goal-directed actions required of the relevant end users in the oil and gas drilling industry. Once an expected functional affordance is actualized, then, it results in an immediate concrete outcome. An example of a specific immediate outcome is also the "enablement of intervention completion installation," which may also be viewed as an "intermediary state." This would be a state between the actualization of the outcome of encouraging engineers to spend more time learning about the content of reservoirs rather than struggling with the challenges of releasing and capturing the hydrocarbons, and Weatherford's ultimate goal of successfully preparing hydrocarbons for future processing in its various commercial forms (Strong et al., 2014).

Affordances from RFID Use

Enables Intervention Completion Installation

Before Weatherford used RFID, the workers needed to move a valve downhole, rig something up, go down with more drill pipes, big long wires, and coils of tubing to get the job done (Murdoch, 2021). The job took longer to do this way and it was risky because there was no guarantee that these equipment could be pulled back out onto surface ground level again. But now, with the use of the RFID tags that have encoded instructions directing how tools should function downhole, the amount of time it takes to do the work has been cut down significantly. Also, the time associated with all the lifting and pressure testing involved in using big heavy drill pipe movements has been reduced as well.

Encourages Engineers to Learn about the Oil Reservoir

With more time in their hands due to the time savings from the operational tasks, the engineers are encouraged to learn more about the oil reservoir, what it contains, and how to extract more hydrocarbons out of the deep wells. With more hydrocarbons extracted, then, fewer wells need to be drilled --- this is good for the environment since less waste will be produced in the production process (Murdoch, 2021; Environmental Protection Agency, 2000).

Reducing the Manpower Required to Work On Site

The TRIP1 system using RFID tags enabled Weatherford to reduce the number of workers involved in drilling wells (Murdoch, 2021). Normally, workers and experts would have to be flown in from different parts of the world. They would, then, flown using helicopters to deepwater exploration sites. There, supply vessels with heavy equipment would have to be sent out to the oil rigs. With the RFID systems in place, Weatherford has lessened the need for both manpower, equipment, and supply boats. In addition to the monetary savings, the new RFID-based method is reducing the carbon footprint associated with oil exploration.

Promoting Worker Safety During Work on Sites

By no longer requiring workers to go downhole, the TRIP1 system will be boosting worker safety (Murdoch, 2021). An RFID system now serves as the automated proxy for work that used to be performed by human workers. The software code etched on the RFID tags, which are subsequently picked up by the RFID readers that work with the tools, will now direct how these should function.

CONCLUSION

Both the Socio-Technical Systems Theory and the Affordances Theory have been useful in understanding the experiences of Weatherford in the deployment of the RFID system for its TRIP1 Completion Procedure. The successful deployment of RFID in this specific application will bring forth positive related benefits as well such as: improved oil recovery --- this means, even after initial production activities have been done with the well, advanced engineering techniques may still be applied in the future in order to extract additional hydrocarbons in the future (Hyne, 2012).

The social subsystem of Weatherford as embodied in the Socio-Technical Systems Theory strongly supports the deployment of RFID in the delivery of its products and services. The focus on team collaboration, development of innovative technological solutions through nurturance of native in-house talent--- especially those driven by environmental sustainability, and the tight governance over risks the firm takes with every project explain the success of Weatherford.

A major hurdle for Weatherford for now involves the technical subsystem ---the need to improve the use of the RFID system so that the tags can be safely and completely transported back to surface after they are used downhole (Murdoch, 2021). Also important is the ability to retrieve data from these tags and subject them to detailed analysis to improve drilling operations. At this point of its development, it appears that this is still an operational challenge for the TRIP1 System. In the meantime, fiber optic cabling is run at the backside of the tools used downhole to capture temperature and pressure data while using the RFID system.

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Social media marketing: A bibliometric study in digital marketing literatures

(*Work-in-Progress*)

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ABSTRACT

After the COVID-19 pandemic influenced the global market, people around the world reduced their visits to physical stores, however opted to make purchases online instead. By providing a platform for their products to be heard during the crisis, the public was able to express their opinion through social media. The purpose of this study is to improve the understanding of "digital marketing" and to examine the effects and factors that influence the use of social media (digital marketing), publication-related journals on online marketing on brands and consumers in the study of digital marketing. The study collected data using the Web of Science (WoS) SSCI database from January 2016 to June 2022 on the topic "Digital Marketing", where 4,295 articles containing quantitative analysis of the relevant literature on Digital Marketing (DM) to find overall trends and predictions were adopted. Six different categories of DM articles were used to classify and investigate the different distribution states in order to find the relevant research developments and division states between 2016 and 2022. Research gaps and DMs are analyzed and synthesized, and a framework for future directions is proposed. This study presents the relevance of digital marketing journal capabilities to the advertising business, research trends and future information in organizing digital marketing (DM), marketing-related research and identifying the core of DM-related research, key aspects of measuring business performance. The proposed dimension of the Digital Marketing Capability Framework is to identify new research directions in the marketing and advertising chain. Systematic evaluation of the relevant literature is categorized at the company level. Key measures of the relevance of digital marketing capabilities to companies (B2C and B2B) and business performance are presented.

Keywords: Social media, bibliometric, digital marketing, Lotka's Law, web of science.

INTRODUCTION

With the increasing competition of digital globalization on the Internet, and even more so after the Covid-19 epidemic, consumers have started to be more receptive to digital marketing, and in advertising has shifted from traditional TV and outdoor media to a large number of online placements, people are using social media to draw closer to their friends through message sharing, posting, liking and commenting, and sharing experiences, and therefore brands are more widely using social media platforms to share their products (Bailey et al., 2018, Dimitriu and Guesalaga, 2017, Martín-Consuegra et al., 2018). Past advertising on social platforms has heavily explored three key areas of the overall user: socialization among friends, the relationship between the user and the platform, and the brand relationship, and how these three relationships affect the perceived value of advertising on social platforms (Ramadan et al., 2018). Although there is a growing body of research on the influence of social networks (SNS) on advertising (Hennig-Thurau et al., 2004; Eckler and Bolls, 2011; Hayes et al., 2016), much of it focuses on the credibility of social network advertising, the recognition of friends, and the influence of preferences and trust on social network platforms. However, with the proliferation of online digital marketing platforms using social networks, active pushing finds data on consumers' preferences, interests, and interactions with brands, allowing brands to move away from relying on followers' interactions and recognition to determine marketing decisions and instead use the conversion rates that brands ultimately expect as their marketing strategy. As a result, digital marketing has revolutionized consumer purchase and acceptance behavior, and a large number of studies on the impact of social media on consumer purchase behavior driven by digital marketing have proliferated to understand the trends in digital marketing and in academic research in general. This paper attempts to understand how the development of digital technology has reshaped marketing processes and strategies, and the implications of this change for the broad space of research we call "digital marketing." Yadav and Pavlou's (2014) article focuses on marketing in a computer-mediated environment and reviews the literature in marketing and information systems. Lambertson and Stephen's (2016) article focuses on consumer psychology, motivation and expression in the digital environment, highlighting some of these. The article by Wedel and Kannan (2016) focuses on the modeling and methodological issues in marketing analytics necessary for the emergence of digital, social, and mobile environments. Our review cites these articles in appropriate sections for more detailed information on issues we have not covered. Based on these findings, we set the agenda for future research on digital marketing capabilities.

RESEARCH METHOD

Bibliometrics was defined by Pritchard (1969) as the application of mathematics and statistical methods to books and other media of communication. Broadus (1987) also defined bibliometrics as the quantitative study of physical published units, or of

bibliographic units, or of the surrogates for either. Bibliometric techniques have been used primarily by information scientists to study the growth and distribution of the scientific article. Researchers may use bibliometric methods of evaluation to determine the influence of a single writer, for example, or to describe the relationship between two or more writers or works. Besides, properly designed and constructed (Moed & Van Leeuwen, 1995; Van Raan, 1996; Van Raan, 2000), bibliometrics can be applied as a powerful support tool to peer review. This is certainly possible for interdisciplinary research fields (Van Raan & Van Leeuwen, 2002). One common way of conducting bibliometric research is to use the SSCI, the Science Citation Index (SCI) or the Arts and Humanities Citation Index (A&HCI) to trace citations.

RESEARCH RESULTS

Distribution by publication years

As Table 1 shows that the publication year of DM articles has keeping rising. The status implicates that DM has great potential to grow in the future.

Table 1: Distribution by Publication Years

Field: Publication Years	Record Count	% of 4,295
2022	542	12.62%
2021	1,272	29.62%
2020	812	18.91%
2019	646	15.04%
2018	446	10.38%
2017	318	7.40%
2016	259	6.03%

Source: web of science database on (2022/07/07)

Distribution by citations

Based on Table 2, it presents that the citation of DM articles has keeping rising. The status implicates that DM has great potential to grow in the future.

Table 2: Distribution by Citations

Field: Citation	Record Count
2022	11,816
2021	20,467
2020	10,957
2019	6,145
2018	2,526
2017	936
2016	209

Source: web of science database on (2022/07/07)

Distribution by countries

According to table 3, we can figure out that the US is at the top with 1,179 (27.45%) in DM, following by England, with 702 (16.35%), respectively. The P.R.C. ranks third with 429 (9.99%). Behind them, Australia, Germany, Italy, Spain, France, Netherlands and Canada are also major academic providers in the field of DM.

Table 3: Distribution by Countries

Field: Countries/Regions	Record Count	% of 4,295
The US	1,179	27.45%
England	702	16.35%
The P.R.C.	429	9.99%
Australia	359	8.36%
Germany	330	7.68%

Italy	280	6.52%
Spain	270	6.29%
France	206	4.80%
Netherlands	190	4.42%
Canada	177	4.12%
India	145	3.38%
Sweden	123	2.86%
South Korea	120	2.79%
Finland	116	2.70%
Taiwan	81	1.89%
Scotland	80	1.86%
Switzerland	80	1.86%
Denmark	78	1.82%
Belgium	76	1.77%
Norway	68	1.58%
Portugal	68	1.58%
Ireland	64	1.49%
Singapore	62	1.44%
Austria	57	1.33%
Poland	54	1.26%

Source: web of science database on (2022/07/07)

Distribution by affiliations

Table 4 is easy to indicate that University of London (132 articles, 3.07%), University of California (UC) System (66 articles, 1.54%) and State University System of Florida (61 articles, 1.42%) are the top three scholarly affiliations in DM research domain.

Besides, University of Oxford, The University of Sydney, Pennsylvania Commonwealth System of Higher Education, University of Texas System, University College London, University of Cambridge and Harvard University are also outstanding scholarly affiliations in DM research domain.

Table 4: Distribution by Affiliations

Field: Affiliations	Record Count	% of 4,2956
University of London	132	3.07%
University of California (UC) System	66	1.54%
State University System of Florida	61	1.42%
University of Oxford	54	1.26%
The University of Sydney	54	1.26%
Pennsylvania Commonwealth System of Higher Education	46	1.07%
University of Texas System	45	1.05%
University College London	43	1.00%
University of Cambridge	42	0.98%
Harvard University	36	0.84%
The University of Melbourne	36	0.84%
University System of Georgia	36	0.84%
New York University	35	0.82%

Udice, French research universities	35	0.82%
Indian Institutes of Management System	34	0.79%
The University of North Carolina	34	0.79%
Erasmus University Rotterdam	32	0.75%
Copenhagen Business School	31	0.72%
University of California, Berkeley	31	0.72%
The University of New South Wales (UNSW Sydney)	31	0.72%
University of Amsterdam	30	0.70%
The University of Manchester	30	0.70%
University System of Maryland	30	0.70%
King's College London	29	0.68%
University of Groningen	29	0.68%

Source: web of science database on (2022/07/07)

Distribution by research areas

Table 5 offers critical information for future research tendencies in DM, allowing researchers a better understanding of the distribution of the top 25 research areas in future research. According to table 5, the top three research areas for DM research domains are Business Economics (1,979 articles, 46.08%), followed by Communication (449 articles, 10.45%) and Environmental Sciences Ecology (386 articles, 8.99%).

Furthermore, this paper's analysis suggests that there are other important research disciplines for DM article production such as Science Technology Other Topics, Information Science Library Science, Computer Science, Social Sciences Other Topics, Engineering, Government Law and Sociology.

Table 5: Distribution by Research Areas

Field: Research Areas	Record Count	% of 1,696
Business Economics	1,979	46.08%
Communication	449	10.45%
Environmental Sciences Ecology	386	8.99%
Science Technology Other Topics	341	7.94%
Information Science Library Science	337	7.85%
Computer Science	291	6.78%
Social Sciences Other Topics	235	5.47%
Engineering	219	5.10%
Government Law	218	5.08%
Sociology	189	4.40%
Psychology	135	3.14%
Public Environmental Occupational Health	134	3.12%
Public Administration	133	3.10%
Operations Research Management Science	98	2.28%
Education Educational Research	95	2.21%
Geography	90	2.10%
Telecommunications	78	1.82%
Cultural Studies	73	1.70%
Health Care Sciences Services	68	1.58%
International Relations	54	1.26%

Substance Abuse	54	1.26%
Medical Informatics	42	0.98%
Social Issues	42	0.98%
Development Studies	38	0.89%
Agriculture	33	0.77%

Source: web of science database on (2022/07/07)

Distribution by publication titles

Table 6 highlights information on trends for DM, allowing researchers to closely approach the distribution of the top 25 publication titles in future research. According to table 6, the top three DM research journals are Sustainability (245 articles, 5.70%), followed by Journal of Business Research (109 articles, 2.548%) and Technological Forecasting and Social Change (73 articles, 1.70%).

In addition, there are a significant number of research sources for DM article production such as Industrial Marketing Management, European Journal of Marketing, International Journal of Environmental Research and Public Health, Journal of Research in Interactive Marketing, Electronic Markets, Journal of Business & Industrial Marketing, Profesional de la información, and Telecommunications Policy.

Table 6: Distribution by Publication Titles

Field: Publication Titles	Record Count	% of 1,696
Sustainability	245	5.70%
Journal of Business Research	109	2.54%
Technological Forecasting and Social Change	73	1.70%
Industrial Marketing Management	49	1.14%
European Journal of Marketing	40	0.93%
International Journal of Environmental Research and Public Health	38	0.89%
Journal of Research in Interactive Marketing	32	0.75%
Electronic Markets	31	0.72%
Journal of Business & Industrial Marketing	30	0.70%
Profesional de la información	30	0.70%
Telecommunications Policy	30	0.70%
Frontiers in Psychology	28	0.65%
IEEE Access	28	0.65%
Journal of Interactive Marketing	28	0.65%
Journal of Theoretical and Applied Electronic Commerce Research	28	0.65%
Media, Culture and Society	27	0.63%
International Journal of Communication	26	0.61%
Journal of Retailing and Consumer Services	26	0.61%
Information, Communication & Society	25	0.58%
Information Systems Research	25	0.58%
International Journal of Information Management	25	0.58%
Business Horizons	24	0.56%
Computer Law & Security Review	24	0.56%
Digital Journalism	24	0.56%
Journal of the Academy of Marketing Science	24	0.56%

Source: web of science database on (2022/07/07)

CONCLUSION

The purpose of this study is to improve the understanding of "digital marketing" and to examine the effects and factors that influence the use of social media (digital marketing), publication-related journals on online marketing on brands and consumers in the study of digital marketing. The study collected data using the Web of Science (WoS) SSCI database from January 2016 to June 2022 on the topic "Digital Marketing", where 4,295 articles containing quantitative analysis of the relevant literature on Digital Marketing (DM) to find overall trends and predictions were adopted. Six different categories of DM articles were used to classify and investigate the different distribution states in order to find the relevant research developments and division states between 2016 and 2022. Research gaps and DMs are analyzed and synthesized, and a framework for future directions is proposed. This study presents the relevance of digital marketing journal capabilities to the advertising business, research trends and future information in organizing digital marketing (DM), marketing-related research and identifying the core of DM-related research, key aspects of measuring business performance. The proposed dimension of the Digital Marketing Capability Framework is to identify new research directions in the marketing and advertising chain. The results in this paper have several important implications. From the distribution of publication year and citation, DM has more potential to grow up and becomes more popular in the future.

The results in this paper have several important implications. From the distribution of publication year and citation, DM has more potential to grow up and becomes more popular in the future.

On the basis of the countries/regions, the US, England and the PRC are the top three countries/territories in DM research. Besides, Australia, Germany, Italy, Spain, France, Netherlands and Canada are also the major academic article providers in DM.

From the distribution of top 25 institutes, University of London, University of California (UC) System and State University System of Florida are the top three scholarly affiliations in DM research domain. In addition, University of Oxford, The University of Sydney, Pennsylvania Commonwealth System of Higher Education, University of Texas System, University College London, University of Cambridge and Harvard University are also outstanding scholarly affiliations in DM research domain.

Judging from the research area, the most important categories in DM provided by Business Economics, Communication and Environmental Sciences Ecology. Besides, Science Technology Other Topics, Information Science Library Science, Computer Science, Social Sciences Other Topics, Engineering, Government Law and Sociology will also become the most relevant disciplines for DM research category.

According to the publication titles, the most enthusiastic supports for DM scholarly publishing enterprise come from Sustainability, Journal of Business Research and Technological Forecasting and Social Change. Furthermore, Industrial Marketing Management, European Journal of Marketing, International Journal of Environmental Research and Public Health, Journal of Research in Interactive Marketing, Electronic Markets, Journal of Business & Industrial Marketing, Profesional de la información, and Telecommunications Policy will also turn into the most critical journals for DM researchers.

Based on the results of this analysis, it is possible to use on future research maps, the quantitative ranges and market segments that have been identified to help provide accurate guidelines for the digital marketing industry data collection to provide a more accurate country or regional guideline. With the massive use of digital marketing and the increase in the number of researchers and users, this study can provide a clear categorization of the two aforementioned, allowing for effective targeting of academic and market needs.

A. Limitation of the study

The results and conclusion are limited and not intended to be exclusive. The journals in WOS adopt stringent journal reviewing criteria, the articles might take one to two years from submission to publication. Therefore, findings in this study may not reflect the most recent research trends.

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The impact of information systems vulnerability announcements on firms' market value

(Work-in-Progress)

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ABSTRACT

With the increasing deployment of IT systems, information systems vulnerabilities have led to a severe negative impact on firms and businesses. This paper aims to examine the impact of information system vulnerability announcements on the market value of Chinese firms. Using the collected security incidents in Chinese firms from 2015 to 2021, we study how characteristics of enterprises and vulnerabilities affect enterprises' market value through event study and regression analysis. In particular, we find that state-owned enterprises suffer larger negative effects than other types of firms. This study also provides companies and managers with insights in decision-making and recommendations from a managerial perspective.

Keywords: Information Security Announcements, Event Study, Abnormal Return, Regression Analysis.

INTRODUCTION

According to the latest data released by the International Telecommunication Union (ITU), the growth in internet usage between 2019 and 2021 was the largest in the past decade. As of 2021, the number of active Internet users worldwide has reached 4.66 billion, accounting for 59.5 percent of the total population (Number of Internet Users 2021 | Statista, 2021). China is one of the countries with the largest internet population. 1.011 billion people have used the internet in 2021, and the internet penetration rate reaches 71.6% (China Internet Network Information Center, 2021). The rapid development of the Internet and related information technologies have greatly changed the people's daily life. However, with the vigorous development of the Internet, more information security incidents occur, causing huge economic losses. There were 1,896 data breaches in 2021, an increase of 23 percent from 2020. IBM's 2021 Cost of Data Breach Report stated that in 2021, each data breach will cost companies an average of \$4.24 million (IBM Security, 2021). For instance, it is reported that a ransomware breach would cost an average of \$4.62 million to affiliated firms.

Thus, the impact of information security incidents on firms is an important topic to investigate. This study aims to answer this question in a Chinese context by investigating following issues: (1) How the market value of Chinese firms will change due to the information security incidents? (2) How the firm's characteristics and attributes of information systems vulnerabilities will impact this change?

This study adopts the event study method. According to our preliminary analysis, we find that the average market value of firms will lose 0.5% on the day when information systems vulnerabilities were announced. In addition, we also confirm that the firm's characteristics and attributes of a company's information systems vulnerabilities will play an important role in the fluctuation of market value caused by information system vulnerabilities.

LITERATURE REVIEW

Researchers had investigated the security issues of information systems from various perspectives. (Zhang et al., 2015) adopted a machine learning approach to analyze hackers' behavior from the knowledge sharing perspective. (Zhang, Shao, et al., 2020) analyzed the patterns and modes of vulnerabilities in firms' information systems by applying the LDA topic modeling method. (Zhang, Xie, et al., 2020) established a common framework to gain a deeper understanding about the characteristics of vulnerabilities and their solutions to ensure the security of enterprise information systems.

Besides, there exist various empirical studies focusing on the impacts of news disclosure on enterprise management decisions. However, compared with vulnerability disclosure, the impacts of information security incidents on enterprises' market value is not well understood, and the existing related research in academia is limited. Some scholars summarized that studies related to impacts of information security on stock prices, and found about 37 related articles (Spanos & Angelis, 2016).

(Aytes et al., 2006) studied the impacts of potential security bugs on the market value of listed companies by examining the impacts of information security bugs announcements on shareholders' value from an economic perspective. It was found that after the announcement of security bugs, the market value of the competitors increases, and the magnitude of this increment depends on the nature of the security bugs. The increase in competitor value is higher when security bugs involve unclassified company and customer information. The impacts are significantly negative when security bugs involve confidential data. (Cavusoglu et al., 2004) analyzed the reaction of capital markets to companies involved and security developers after the incident, and found that the impact of security incident disclosure is not limited to the companies involved, but also to the market value of Internet developers. (Yang et al., 2021) examined the companies' responses to network vulnerabilities after security incidents, and found that factors such as sentiment in the vulnerability repair plan, vulnerability report anonymity, vulnerability type, vulnerability risk level, and the industry sector to which companies belong have significant impacts on the companies' response. Using event study and regression analysis, (Ye & Zhang, 2021) found that the enterprises related to such events will suffer from a market value loss. They also investigated the moderating effect of companies' characteristics and attributes of security events on this effect. Using event study approach, (Wang & Zhang, 2022) compared and analyzed impacts of non-information security events and information security incidents on enterprises and identified various factors adjusting such impacts. (Das et al., 2012) proposed to identify factors which could modulate cumulative abnormal returns (CAR). They found that company type, company size, and the risk level of attacks can independently regulate CAR.

HYPOTHESES DEVELOPMENT

How the stock market responds to the information security breach announcements depends on the attitude of people to the incidents. Generally, when a security incident happens, people's property or information will suffer loss. Therefore, most people will maintain negative views on the incidents though other factors may influence their view. This is consistent with previous studies. Thus, we have:

Hypothesis 1: Information security vulnerability announcement negatively affect the market value of firms.

Firm Type

State-owned enterprises (SOEs) play a critical role in Chinese economy and even the global economy (Lin et al., 2020). The number of SOEs in Fortune Global 500 (FG500) has increased from 27 in 2000 to 102 in 2017, and the revenue of FG500 SOEs reached 22% of all FG500 companies (Lin et al. 2019). In particular, China's SOEs are an essential component of global SOEs. Chinese SOEs have advantages in maintaining social stability and maximizing resource mobility. Thus, they draw better attention from social and investors. When there is an information security vulnerability announcement covered by the media, it may have a higher negative impact on the SOEs. It leads to our second hypothesis:

Hypothesis 2: When facing the announcement of information security vulnerability, the market value of SOEs will be negatively affected in a higher level than that of non-SOEs.

Firm Assets

The impact of the information systems vulnerabilities may be related to firms' intangible assets. In the stock market, investors usually evaluate the information security investment of a firm by its intangible assets. When information security incidents occur, a firm owning more intangible assets may lose more trust from investors, who may be skeptical about the effectiveness of information security investments. Thus, we propose the following hypothesis:

Hypothesis 3: When facing information vulnerability announcements, firms with more intangible assets will suffer higher negative impacts than those with less tangible assets.

Time Effect

As time goes by, both the number and diversity of information security breaches increase. All kinds of news about the vulnerabilities stimulate the nervous nerves of people, who have become more sensitive to privacy and safety. Therefore, when a new information system breach is announced, people have less tolerance for it compared to the past, leading to more losses in a firm. Thus, we put forward the following hypothesis:

Hypothesis 4: Information systems vulnerabilities will have a greater negative impact on the firm's market value than those in the past.

DATA AND METHODOLOGY

Data Collection

To collect information security incidents, we searched in domestic high-impact portals with specific keywords. We use the combination of two groups of keywords, one group includes "system", "security", "information", and "platform" and the other group includes "vulnerability", "breach", "privacy" and "incident" respectively. We limit the search period between 2015 and 2021. Initial data is preprocessed according to the following criteria: (1) The listed company must be listed for at least three months; (2) The historical stock data of the listed company should be available from 5 days before the announcement day to 5

days after the announcement day; (3) If the event is reported multiple times, the event date should be selected as the earliest announcement.

Finally, we conducted 54 observations on the information security vulnerability announcements of 34 companies. In general, associated enterprises are distributed in various industries, with over 70% of enterprises belong to the financial industry and high-technology industry.

Event Study Methodology

We use the event study methodology to estimate the impact of information security vulnerability announcements on the market value of firms. This methodology has been widely used in economic and finance research (MacKinlay, 1997). Based on the market rationality, changes in the stock values can immediately reflect the impact of one certain event in the market on firms. Thus, the impact of the information security vulnerability announcement on the market value of firms can be investigated by the change of stock value on the event date via event study methodology.

The first step is to calculate the return of the stock using the Capital Asset Pricing Model (CAPM) in our study. CAPM assumes that a linear relationship exists between the market return and the return of a stock. The model is as follows:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad (1)$$

which is the return of the stock i on day t ; R_{mt} is the return of the market on day t ; α_i and β_i represent the intercept and the slope parameter of the stock i respectively; ε_{it} is the disturbance term of the market model.

The stocks of the companies we selected are from three markets. Thus, we use the NASDAQ, HKEX, SZSE market index return as the proxy of the market return respectively, depending on which market the stock i in. The period of the event window is important, and a shorter event window is preferred in event study (McWilliams & Siegel, 2017). Previous studies used a 2-day event window, the day of the announcement and the day after the announcement, to capture the impact of an announcement made after the stock market close (Cavusoglu et al., 2014). Others chose a 3-day event window, starting on the day before the announcement and ending on the day after the announcement (Das et al., 2012). They avoided the effect of information leakage before the announcement. However, in our study, we choose a 1-day event window. It not only increases the power of the statistical test but also reduces the effect of the confounding events. We need to set an estimation window to estimate the parameter α_i and β_i . Generally, the estimation window, between 120 days and 200 days, is a period that is prior to the event window. In our study, we choose the period from 170 days to 10 days before the event day as our estimation window.

Next, the abnormal return (AR) of the stock i on day t can be concluded by:

$$AR_{it} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i R_{mt} + \varepsilon_{it}) \quad (2)$$

The abnormal return measures the difference between the actual return and the expected return of the stock i on day t . The cumulative abnormal return (CAR) of the stock i can be calculated over the event window by:

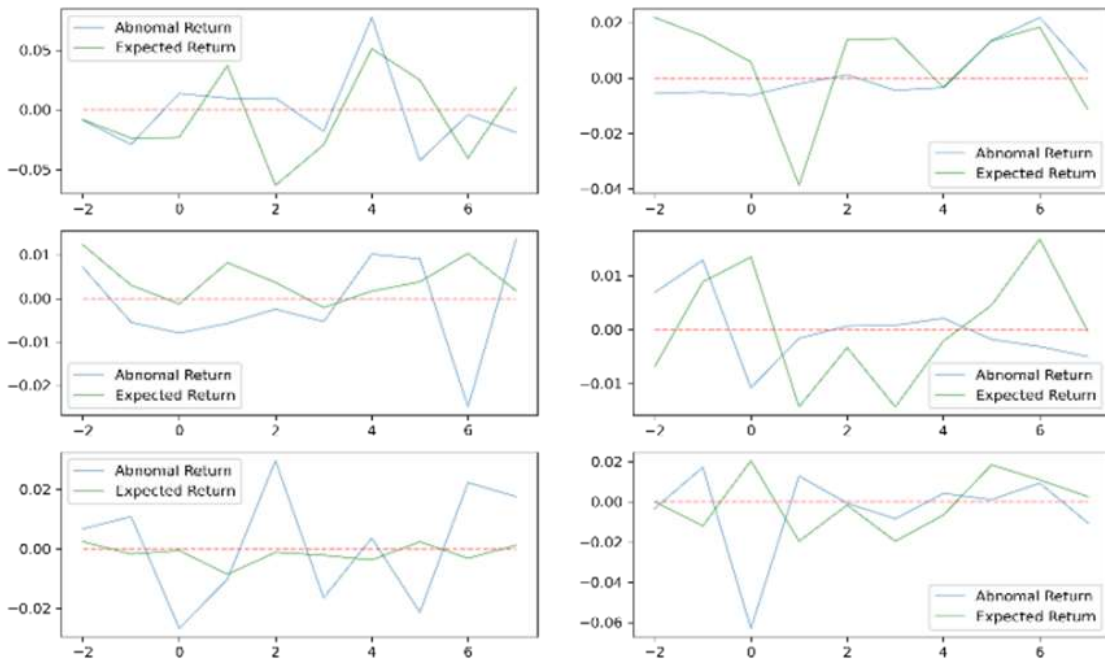
$$CAR_i = \sum_{t_1}^{t_2} AR_{it} \quad (3)$$

where t_1 and t_2 represent the starting date and the ending date of the event window.

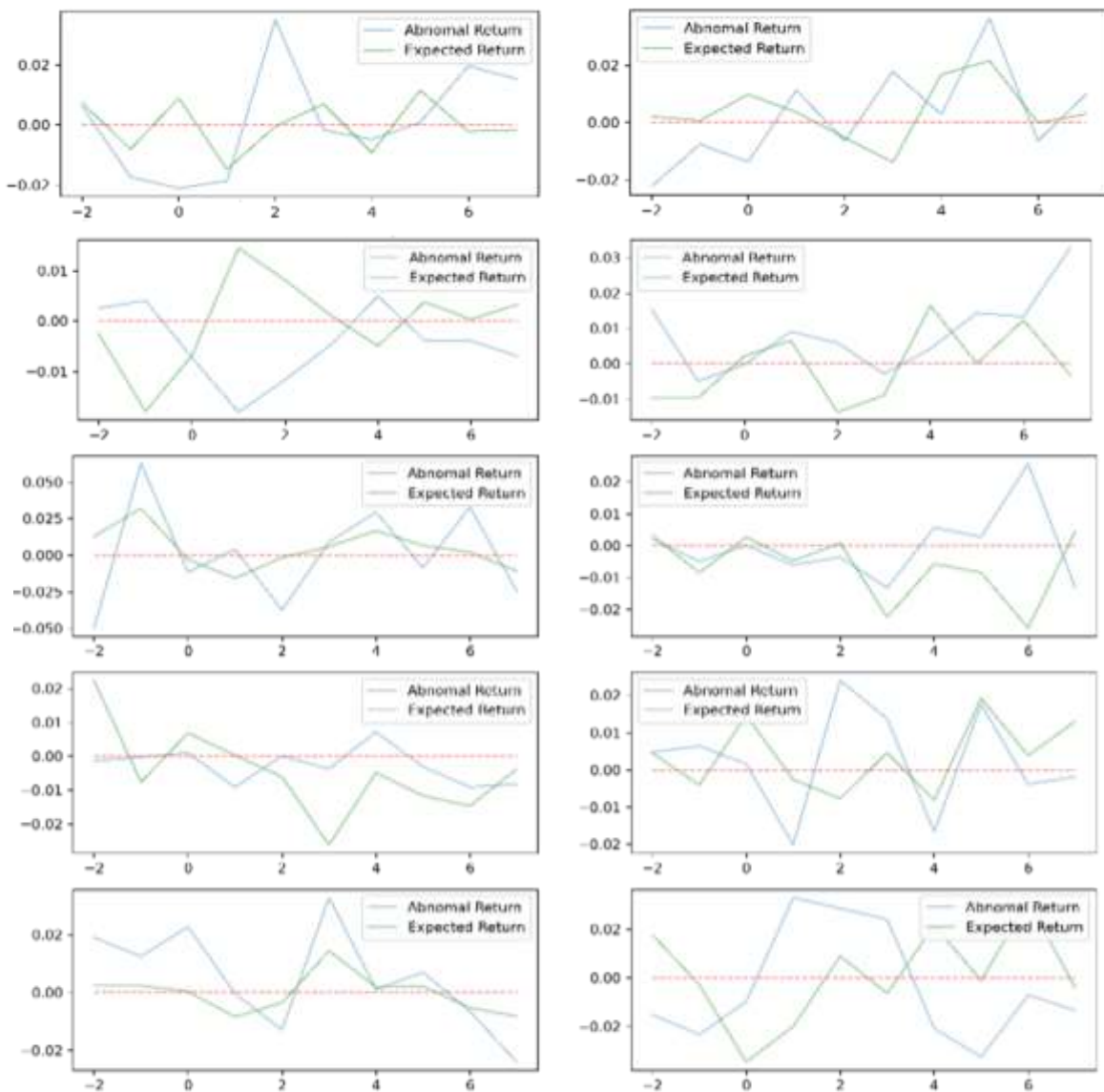
The mean of cumulative abnormal return of all N events can be calculated by:

$$CAR = \frac{1}{N} \sum_{i=1}^N CAR_i \quad (4)$$

Table 1 summarizes the results produced by the event study methodology. In the table, the mean cumulative abnormal returns and p values from the t-test are represented. The mean cumulative abnormal return on event day (day 0) is negative and statistically significant, which suggests that the market value of the firms suffers a negative effect on the announcement day of. The mean cumulative abnormal return on the day before the event day (day -1) is positive and not significant, showing that there is little effect of news leakage. The mean cumulative abnormal return on the day after the event day (day 1) is negative but not statistically significant, suggesting that the impact of the announcement lasts for a short time. All p values are one-tailed.



(a)



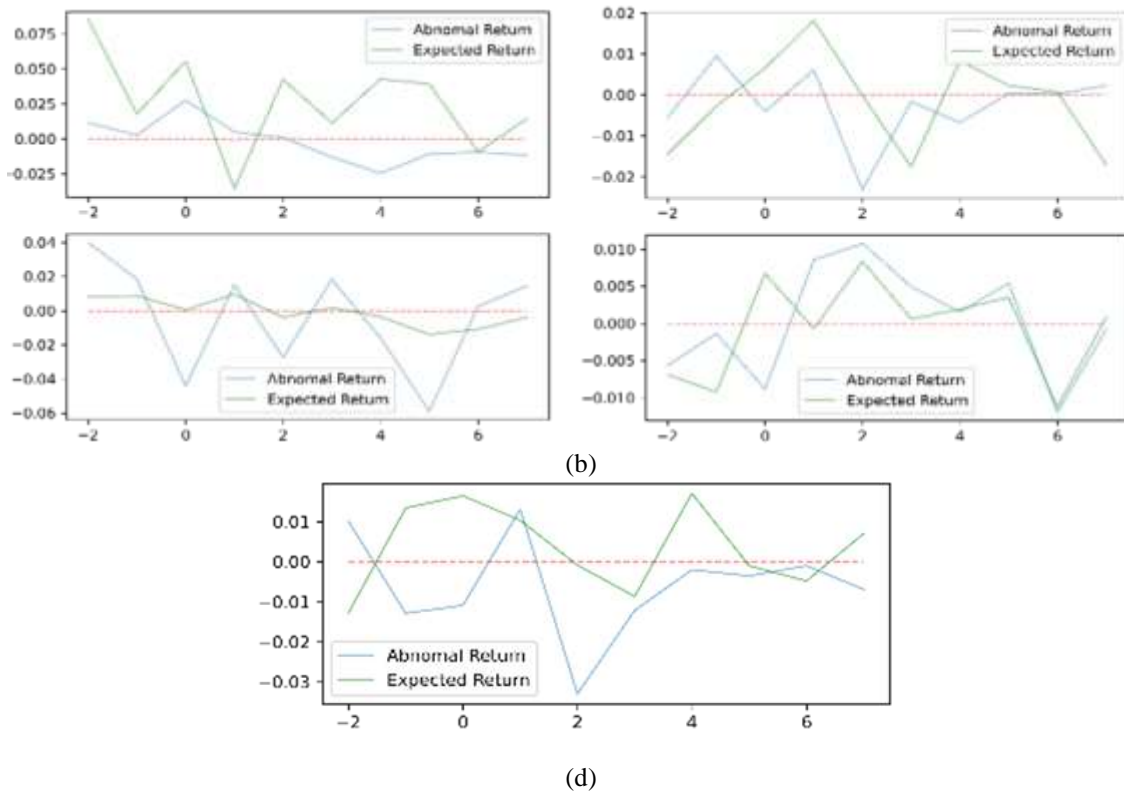


Figure 1: Abnormal Return and Expected Return of Some Incidents

Table 1: Mean Abnormal Return

Day	-2	-1	0	1	2
Mean abnormal return	0.005 (0.05)	0.000 (0.44)	-0.005 (0.03)	-0.003 (0.13)	-0.003 (0.19)

DATA ANALYSIS AND RESULTS

Regression Analysis

To verify our hypotheses, we develop a multiple linear regression model as follows:

$$AR_{it} = \alpha + \beta_1 Tangible Asset + \beta_2 Intangible Asset + \beta_3 Growth + \beta_4 Operations + \beta_5 Finance + \beta_6 SOEs + \beta_7 Time + \beta_8 Severity + \beta_9 Response + \beta_{10} Type + \beta_{11} Source \tag{5}$$

The description of independent variables is as follows. Tangible asset and intangible asset represented by the variable *Tangible Asset* and *Intangible Asset* are calculated by the natural logarithm of the tangible asset and intangible asset of the firm. The growth rate of the firm will influence the reaction of market to the vulnerability. It is measured by the variable $Growth = \frac{Asset_{current} - Asset_{previous}}{Asset_{previous}}$.

The operation of the firm can be measured by basic earnings per share, which is represented by the variable *Operation*. To define type of the firm, we use $Finance = 1$ if the firm is in finance and $Finance = 0$ otherwise. In a similar way, $SOEs = 1$ if the firm is a stated-owned enterprise and $SOEs = 0$ otherwise. In order to measure the time effect, we denote the initial year (2015 year) as 0, the second year as 1, the third year as 2, etc. For vulnerability, $Severity = 1$ if the vulnerability is severe, and $Severity = 0$ otherwise.

Additionally, we have the following control variables. First, we use the variable *Response* to control the firm's action or response to the announcement, which is a dummy variable. When the firm has an active response and takes appropriate action to the vulnerability, like providing a patch or paying compensation for stakeholders, $Response = 1$. When the firm admits the incident, $Response = 0$. Importantly, if the firm doesn't take action to the incident and denies it, $Response = -1$. Second, the type of vulnerabilities is measured by the variable *Type*. $Type = 1$ if the vulnerability is related to confidential information and $Type = 0$ if not. Third, we also control the source of the news. $Source = 1$ if the news is form official media and $Source = 0$ if not. Table 2 shows the descriptive statistics of all variables.

Table 2: Descriptive Statistics of the Variables

Variables	Mean	Max	Min
Tangible Asset	18.13	21.72	12.41
Intangible Asset	13.36	16.71	8.20
Growth	0.17	0.76	-0.64
Operation	4.89	32.95	-8.71
Finance	0.24	1	0
SOEs	0.5	1	0
Time	3.5	6	0
Severity	0.43	1	0
Response	0.31	1	-1
Type	0.41	1	0
Source	0.3	1	0

Results

The results are listed in Table 3. The R^2 of the model is 31.6%, and the adjusted R^2 is 13.7%. They are sufficient enough to explain the abnormal stock return. Furthermore, the variance inflation factors (VIF) for our model is below the recommended level of 10. Some interesting phenomena are observed from our model. First, the coefficient of *Tangible Asset* variable is negative, while the coefficient of *Intangible Asset* is positive, both of which are significant ($t = -3.186$, $p = 0.003$; $t = 2.280$, $p = 0.028$). It suggests that firms which have more tangible assets will suffer more negative effects, while the firms which have more intangible assets will be less negatively impacted. On average, the market value of firms will lose by 0.79 percent if the tangible asset of firms increases by 1 percent, while the market value of firms will increase by 0.5 percent if the intangible asset of firms increases by 1 percent. Second, the coefficient of the finance is positive and significant ($t = 2.386$, $p = 0.023$), indicating that the financial industries suffer more negative effect. Third, the coefficient of *SOEs* variable is positive and significant ($t = 3.439$, $p = 0.001$), showing that the State-owned enterprises suffer more negative effects. Besides, the variable *Time* has a positive and significant ($t = 2.089$, $p = 0.043$) coefficient. Information security incidents in recent years have greater negative impact on enterprises than those in the past. However, the coefficient of variable *Severity* is positive but not significant, indicating that there is no significant difference in abnormal returns in terms of vulnerability severity.

Table 3 Regression Results

Variables	Coefficient	t-statistic	p-value
Tangible Asset	-0.0079***	-3.014	0.004
Intangible Asset	0.0050**	2.146	0.038
Growth	-0.0065	-0.336	0.739
Operations	0.0007*	1.753	0.087
Finance	0.0233**	2.202	0.033
SOEs	0.0253***	3.332	0.002
Time	0.0027**	2.043	0.047
Severity	0.0097	1.445	0.156
Response	-0.0018	-0.540	0.592
Type	-0.0010	-0.153	0.880
Source	-0.0065	-1.081	0.286

Note: *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, * denotes significance at the 10 percent level

CONCLUSION AND DISCUSSION

This study uses the event study methodology to explore the impact of information systems vulnerabilities announcement on firms' market value. We focus on Chinese companies and study the behavior of SOEs in the face of the information systems vulnerabilities.

We find that there exists a statistically significant negative correlation between the information systems vulnerabilities announcements and the market value of firms. Information security incidents will cause more negative influence on firms owning more intangible assets. In addition, we also observe the financial firms and SOEs will suffer more losses than others. What's more, information security incidents will cause more harms to the companies than in the past.

Based on the above results, some implications are summarized as follows. First, companies need to increase the information security investment to reduce risks because investors and customers have less tolerance for vulnerabilities. For example, they

can invest more cost on inspection and maintenance. Second, financial firms pay more attention to customers' privacy and improve their confidence in the companies. It can reduce customer losses after security incidents happen. Third, companies need to be more cautious when choosing the vendors of systems and establish a more professional information security team to deal with emergencies.

Finally, due to its special social status, state-owned enterprises will suffer more losses under the same conditions. They should pay more attention to the occurrence of information security incidents, especially when the country advocates new digital infrastructure and information security.

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The learning dimension of digital transformation: Transforming with learning patterns

(Work-in-Progress)

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ABSTRACT

The road towards a digital organization is partly technical but also about the skills and mindset of the personnel of the company. As the technological base for digitalization is fairly straightforward, the ways of supporting change in people are not evolving as rapidly. This paper suggests an approach to continue learning in an organization, based on concepts around pedagogical theory, learning patterns. This theoretical framework is transferred into a business setting, and the consequences are discussed from the digitalization perspective.

Keywords: Digital transformation, Organizational change, Learning patterns, Pedagogical theory.

INTRODUCTION

The digital transformation challenge that most organizations and businesses face has many layers to it (Westerman, 2014; Schallmo et al., 2017). The digitalization technology is just one layer, and probably the one coming later in the transformation process. Tabrizi et al. (2019) point out that technology is not the main issue with digitalization. There are many other areas that must be managed, including: the business models, the organizational structures, workflows and processes, and the people dimension, all of which need to be in good order before any technology changes (Sathananthan et al., 2017). In a very general manner, the digitalized company could be described as a situation where the core of the operations and processes are digital, and the company has a strategic dependency on its digital resources. The organization is moving from people aided by digital tools to a situation where people are a part of digital organization. Digital transformation implies an all across the board technology intensive organization, demanding that people gain new skills and an ability to radically change their worldview of how business value is created (El Sawy & Pereira, 2013). Vial (2021) provides a concise definition of the concept of digital transformation: “a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies.” There is a characteristic of digital transformation technology of being disruptive, creating the bases for big changes, as argued by Ebert and Duarte (2018).

In the big picture and in the direction of this paper, we are talking about a profound change in worldviews. This means there is a need to accelerate the learning culture of an organization in order to create both mindsets and skill sets that will make the transformation possible (Svahn et al., 2017). This will be the precursor for a strategic rethinking of an organization's value creation and delivery, building on customer relations based on real-time quality data. In practice, the development of the different fronts of learning, strategy, and process changes are concurrent efforts, but learning will pave the way. Learning is not only about new skills and organizational capabilities, but it is also about changing mindsets and worldviews. It is not just a teaching effort and skill training; rather, it is about building flexibility capabilities among those that will be in demand in a data driven business. Reality changes quickly, and doing business based on real time data requires the ability to rethink and retool the business processes (Bharadwaj et al., 2013). Changing worldviews and acquiring new skills take time and effort and should become a part of daily operations. The tasks and processes of the organization must include learning and change components. However, it cannot be locally and individually based efforts; instead, there needs to be a systemic dimension to learning. In the same way, it cannot just be centralized top-down pushes, or novelty growing in close communities from below; on the contrary, there needs to be an integrated strategy for learning for change.

Regardless of how you make the effort, organizational learning or learning organizations, as a structure or processes, there have been many approaches to the challenge. Besides the traditional corporate training, onboarding, up- or re-skilling, based on the traditional means of education, several different strategies for learning can be noted.

- Action research (Revans, 1980), a worker driven approach, where individuals and groups experiment with new ways of working and improving operations.
- Communities of practice (Wenger, 1998), where there is informal learning among special interest groups.
- Knowledge management (Nonaka and Takeuchi, 1995), where there is a formal setup of knowledge processes, from knowledge creation to transfer and application of new knowledge.
- Organizations Learning (Senge, 2006), which is a systematic approach to create behaviors and structures that promote a learning organization.
- Learning organizations (Garwin, 2003) presents the specific learning organization concepts. Here, three modes of learning—intelligence gathering, experience, and experimentation— are discussed as well as how they can be effectively deployed.

- PDSA cycles (Deming, 1986), PDSA or the Deming wheel, are strategies and methods to develop, test, and implement changes that can result in improvement.

In this paper, we look at a pedagogical model, which could serve as a blueprint for creating learning patterns for a systematic learning effort of an organization. The paper is organized as follows: we start by presenting a framework for strategic digitalization in order to provide an outline of the challenges of digitalization. Then, we go on to present a pedagogical framework, which we then transfer to an organizational setting. Thereafter, we provide an illustration of how to work with this. Finally, in the discussion, we show how the challenges of digital transformation can be tackled.

MODELS FOR DIGITAL TRANSFORMATION

To understand the challenges of the digital transformation and what forces of change are involved, we use a model presented by Bharadwaj et al. (2013) as a starting point for a discussion on learning processes.

Scope of a digital business strategy

The scope of a business is about the interconnection that digitalization offers for the creation of digitalized business networks. For example, creating new products and re-developing them based on real-time feedback from extensive business networks, including all links in the value chain. The digitalized business networks break traditional business boundaries, including networks, ecosystems, alliances, and partnerships with both competitors and customers. There is an ongoing continuous change in these connections, what could be called the plasticity of relations of the loosely coupled networks over time.

Scale of a digital business strategy

The scale of a business is about reaching higher sales levels in larger markets. Techniques such as “cloud computing” enable the rapid up-scaling and down-scaling and allows for moving in or out of new markets. Multi-sided business models afford the organization to create new businesses on the back of traditional markets; for example, selling information gained in operations or selling services to suppliers, creating values in new parts of the value chain. This is about understanding a business from new perspectives, uncovering hidden values. A key strategy for understanding data as a strategic resource is captured by concepts such as “big data” or “analytics.”

Speed of a digital business strategy

The speed of the processes of the organization, such as product launching, decision-making, value chain reconfiguration, and network formation, is a key to success. The faster a company can react to new circumstances in the environment, the better it can adapt and act in a changing world. A key to such a dimension is the changing demands from customers. There is a level of dependence on the behavior among external partners, and how to influence that is a challenge.

Sources of business value creation and capturing

Four sources of value creation are discussed, including: information, multi-sided models, the co-creation of value in networks, and digital architectural points of control. An example of creating value from information could be driving direct sale, based on real-time data from consumer behavior. Finding new opportunities in current business models is an innovation effort to understand new values in already existing resources; for example, selling data from core processes could create a new side of an existing business model. Value creation, by inter-linking with new partners along the value chain, can come from creative thinking and the discovery of opportunities that can only be realized by digital integration, creating a network of cooperation. Depending on a company’s position in a digital network, value can be derived based on technological control of digital resources, for example, by creating gate keeping positions or choke points for information flows.

PEDAGOGICAL MODEL: LEARNING CYCLES FOR CONCEPTS AND PRACTICE

In the end, a learning process aims at personal change and development of the individual’s goals, knowledge, and practical capability. Learning is a complex process and needs to be in sync with the challenges at hand; a digitalization process carries many of these. Learning is a process of acquiring skills and knowledge needed to perform actions to reach goals. To achieve this, teaching should be approached as a design science (Laurillard, 2013) in order to cope with new environments, and new cultural and technological resources. Patterns of how learning should be conducted need to be created based on the conditions of learning. The technologies used for creating the learning experience are an important part of these conditions, that is, different kinds of digital tools create new possibilities for learning. In this sense, the digitalization that drives the need for learning and change also contributes to new possibilities for supporting said change through novel learning processes. This is a key challenge of how the new digital landscape of an organization also provides new conditions for knowledge, change, and learning in that organization. The learning cycles are a blueprint for the deployment of digital learning tools; each learning action should, according to Laurillard, (2013), be matched with suitable technologies.

Laurillard (2013) sees a need for designing a set of learning activities and interactions between people or roles of the learning process. These actions need to be designed into learning cycles or teaching patterns, that is, interactions between teachers, learners, and peers of the learner. The design of these cycles or patterns is made with a number of components: learning actions, roles, etc., are organized into the learning cycles. The learning includes several dimensions; first, in terms of involvement, including both social and individual processes. The content of the learning includes both conceptual and practical elements: These are concepts that are used when talking about a subject and practice, and how to act based on the knowledge to reach practical goals. The content of the learning is material about concepts, models, theory, etc., by which the learner may acquire

the abilities to perform the needed actions. The understanding of the concepts is refined based on discussions, feedback, and commenting with peers and teachers. Based on the conceptual knowledge, the learner develops a practice, taking actions and reforming the practice based on feedback on outcomes, while refining goals.

The core set of pedagogical patterns include:

Acquisition, where the learner listens or reads the learning material, typically a lecture or a book.

Inquiry, where the learner is actively working with the material, for example, exploring, comparing, and reviewing documents or other teaching resources.

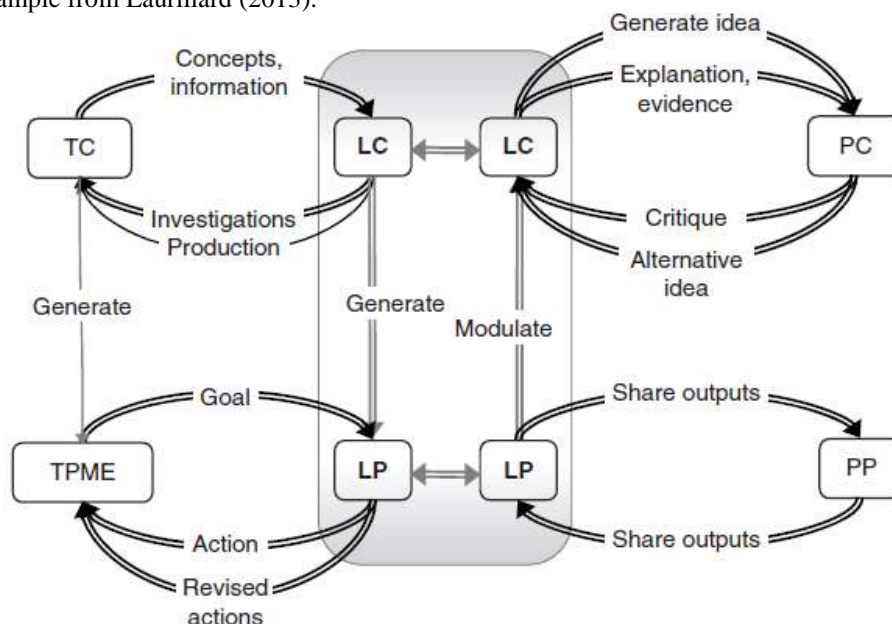
Collaboration, where the learner interacts with other learners, for example, in problem-solving or practical workshops. Collaboration is a process of knowledge building through participation and negotiation with peers.

Discussion, where there is learning through the articulation and debate on ideas and questions together with peers and teachers.

Practice, where the learner takes on actions based on his or her acquired knowledge and improves it based on how well his or her actions lead to the stated task goal, and uses the feedback as a self-reflection or critique from others to improve their next action.

Production, where the learning creates one's own knowledge artifacts, and where the knowledge is consolidated and articulated using the conceptual apparatus of the knowledge area, including detailing its practical applications.

The patterns are elaborated using diagrams, “conversational frameworks,” describing how the main roles as teachers, learners, and peers interact during the learning process. These interactions are focused on two fronts: a conceptual learning and a practical learning. This creates six major elements of the learning process: teacher concept (TC), learners' concepts (LC), peer concepts (PC), and another three for the practice focus (TP, LP, PP). In the case of collaborative learning, a generic framework could look like the sample from Laurillard (2013).



Source: “Learning through collaboration as a combination of learning through discussion and sharing of the outputs from practice and inquiry.” Figure 1.11 , Page 191. Laurillard, 2013.

Fig. 1. Example of the learning cycles: Collaboration

The construction of a learning pattern would mean working with such generic patterns as starting points. Depending on the needs of the teaching material and the learning environments, an active phase of design is needed to reach a solution. A simple cycle could be “T: explains concepts, L: reads texts, L: writes essays, T: marks essays.” Regarding collaborative learning, other patterns could be interwoven as building blocks (for example, acquiring, analysis, practice). The learning pattern is constructed by creating a script; the script consists of a number of learning cycles. In the collaboration case, several cycles can be seen; for example, the learner is seen in cooperation with peers in several activities, including idea generation, providing supporting evidence, taking actions, types of representations, and more.

RESULTS: FRAMEWORK FOR OL AND DT

The theoretical frame by Laurillard (2013) is aimed at higher education and formal education. Formal learning is a situation of learning that might be very different compared with an organizational setting. However, the basic modeling technique and the generic set of learning situations suggested by Laurillard (2013) can contribute to targeted solutions of specific challenges in organizational learning (OL) and digital transformation (DT). The formal teacher is clearly not a natural position to be found in an organization. However, experts, technical consultants, change managers, or trainers of an organization would fill the role, and if these have less of a pedagogical background, working with the design of learning patterns would probably help them greatly. Any of the learning patterns as presented above could find good use in an organizational setting. The acquisition

pattern would fit the basic training of a company's standard procedure, in a simple "read – lecture – test – feedback" pattern, and in an extended version, contribute to more elaborate learning designs.

Looking at the challenges of the digital transformation process, as briefly discussed above, training on many levels could be necessary. The characteristics of digital transformation, as expressed with the scale, scoop, speed, and value dimensions, are the radical rethink that is required of the organization. Tackling the world-shifting dimension that is in hold in a digital transformation, collaborative and discussion learning patterns seem fitting. Laurillard (2013) describes collaboration as leading to the production of something new, i.e., solutions as outcomes of discussions.

The underlying pedagogical theory of collaboration could be traced back to variation on social constructivism (for example, Vygotsky, 1978). There are a number of central themes here: the nature and use of language, how discussion shapes the mind of the participants, and communication as a path to learning. People sharing worldviews and mental models, as well as new and better outlooks on the shape of the future emerge when different views meet. In particular, the scale and scope of dimensions of digital transformation speak of the need for radical rethinking.

Based on the learning cycles, Laurillard (2013) discusses the need for digital tools as a support and enhancement of the learning cycles. The learning actions, as discussed in this learning framework, are generic and in a way timeless. The implementation or realization of them is discussed by Laurillard (2013) to be digital to their nature. These suggestions and examples given at that time might be more or less outdated. Today, the collaboration script, where interactions between people are described, could be realized in a virtual reality room. Meetings in a virtual room, based on VR helmet technology, could be a way of creating collaboration, but there are many questions about whom to invite, how many, the principals for interaction, etc. Even more novel technologies could be put to use, for example, 'holographic communications technologies,' 'holographic calling,' 'holographic telepresence,' 'holographic type communications' (HTC) (Clemm et al., 2020). The learning experience in a workshop with full sized holographic representations of the participants will certainly affect the nature and quality of the interactions, when comparing to video meetings of today. The learning action of "critique" becomes markedly different if it is possible to act in full body language compared to, for example, in a video conference situation. The advent of new and more powerful tools for learning and knowledge transmission will continue to redefine the learning cycles and the impact on the organization in terms of change and transformation to new states.

The digital transformation process has many layers to it, from the choice of a business strategy down to actual learning actions that create new personal knowledge and change in behavior. The important thing is to work in the right order; hence, a business strategy first, and then start with the digital transformation process. Furthermore, a learning environment must be created on a principal level before learning technologies are selected and implemented. The key to finding the right recipe for organizational learning is the design dimension, namely the learning cycle is the design for the particular challenges of the situation at hand.

Four layers can be discerned, which are interconnected in change cycles, all with a component of people learning and changing as the pivotal point:

- Data, the data flows, which inform the organization of the changes in the internal and external states, more or less in real time. This is a driving engine and pushes the organization forward, adapting or acting to change the environment.
- People, learning from the data flow, interpretations and sense making as key processes, leading to actions. These insights will have an impact on the digitalization process based on what works or not.
- Digital transformation, the process of changing the origination, its processes, and business practices by the application of new digital tools.
- Business strategies, development of new business models, value change configuration, how resources are gained and deployed toward the stated goals, all in accordance with the demands and restrictions of the environment, and long-term value creation for the stakeholder.



Source: authors.

Figure 2. Learning and change- connection strategy, digital transformation, people and data

The cycles embedded in this model go both inside out and the reverse from the outside and inwards. In an inward going spiral, strategy defines the need for digital transformation, providing people with new tools to act in the organization toward goals, feeding on and driving the processes that are built around the data streams. In an outward moving spiral, the data flow in from the people on real time states of internal and external changes, providing the people in the organization with a new understanding on which to act. This might redefine how digital technologies are applied, and the strategies that guide the transformation processes. In the center of the cycles or spirals, we find people learning and changing their behavior, as the strategy and real-time data put pressure on them. How these learning activities are balanced and designed will be the decisive point of the digitalization process.

DISCUSSIONS: ORGANIZATIONAL APPLICATIONS AND IMPLICATIONS FOR TRANSFORMATIONS

We can see a number of discussion points based on this exploration of the usage of a more traditional pedagogical theory in the context of organizational learning. The purpose is to bring a level of pedagogic rigor into the design of learning processes. The purpose is to think critically about the steps proposed, and not just a set of lectures and workshops, or what standard training recipe might be at hand. These include a structural aspect of the design of learning, but also the use of certain patterns, as mentioned above, with a focus on discussion and collaboration.

It should be noted that the pedagogical approach discussed in this paper does not replace any change model or model for organizational learning. The focus is on improving the learning process that is at the heart of the change process. Learning is the change of behavior and acquiring new knowledge, and there is an essential set of general actions that could be involved, regardless of the action. In Senge's (2006) model of a learning organization, for example, an ideal end state is envisioned. However, how an individual achieves personal mastery, and how the organization can be organized to support that pursuit, is not really discussed. To create a learning environment that can, for example, facilitate the building of a shared vision, the learning through collaboration script could be implemented. A collaboration script is a set of instructions prescribing how students should form groups, how they should interact and collaborate, including details such as the group size and composition, sequence of learning actions, roles, timing, and much more.

The argument here is that there is a need for a more formal understanding of learning processes that goes beyond the straightforward solutions such as reading up on practical instructions, discussions in workshops, and application in a trial-and-error mode. Breaking down learning into clear stages and steps based on a firm theory of learning (goals, actions, practice, feedback, etc.) provides a basis for integration of learning into the normal operations. Learning should be an integrated part of everyday operations; in light of this, the meaning of organizational transformation becomes an ongoing process, which is what the digital revolution means. Digital transformation is a constant state of change, with the mega data of the fully digital business landscape keeping a pressure on the individual to rethink how the world works or could be made to work better.

Use of IT for learning is a key component in the work of Laurillard (2013), where each action in the learning pattern should be supported by an IT component. As such, it falls into the general paradigm of digital transformation; just as any process in the organization is challenged by new technologies, so too are the training and learning process. The increased data about the world will create much greater speed, covering a greater scope and scale of operations, and will inform the individual about what works or does not. The speed of the transformation paradigm is the major challenge for a learning organization, with shorter cycles of what works and what is good. The learning processes should be directly connected to the operations, integrated as a self-adjusting part of the operations.

The use of the design perspective made by Laurillard (2013), viewing the creation of learning cycles as design thinking, connects it to the overall design effort of the digital transformation process. The learning processes become one component in the digital effort of the company. The flows of big data would be, in this sense, connected and fueling the learning processes and the learning processes become a part of the transformations. Hence, it connects the organizational design into the learning cycles, making the learning the facilitator of digital transformations. Value creation is a process of learning and innovation in a collaborative mode. Achieving speed advantages, that is, the rate of change that can be reached, is a quality of the learning pace that the organization can muster.

At the end of the day, there are just so many ways of educating or training people, whether it is in a school situation or in a company. There will be a mix of lectures, quizzes, tests, assignments, workshops, practice sessions, discussions, mentoring, coaching, reading of books, watching videos, doing write ups, giving feedback, or any other trick in the book of teaching. The conversational frameworks, as a means to construct dedicated learning environments, offer a way to tailor, in a structured way, the organization, based on the challenges at hand.

ACKNOWLEDGMENTS

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Transforming nested structures of flowchart into hierarchical coloured Petri Nets

(*Work-in-Progress*)

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ABSTRACT

Flowchart is commonly used diagram to represent the processes in design phase of a software system. However, the flowchart of a complex software system inevitably contains the nested structures of branching and looping of the processes. The verification of these nested structure of the flowchart in advance is still difficult to conduct even using simulation techniques. In this paper, we intend to consider the complex flowchart with nested structures, so called nested-if and nested-loop, as our input design model. A set of mapping rules is proposed to transform the input complex flowchart with nested structures into the hierarchical coloured Petri nets to avoid the drawing of a single huge net of complicate model. The hierarchical coloured Petri nets also provides us to manage level of abstraction of the formal model and helps us concentrate on only an appropriate detail at a time. In our transforming approach, both data flow and control flow of the processes in flowchart are concerned as well so that all changing states of the observable variables in the flowchart would be represented and simulated in our resulting hierarchical coloured Petri nets. The CPN simulation tool is used to test and ensure the correctness of our resulting hierarchical coloured Petri nets.

Keywords: Flowchart, Nested structures, Formal verification, hierarchical coloured Petri nets.

INTRODUCTION

In the software design phase, one of the common tools that are practically used to represent to process of the software system is flowchart. In order to assure the validity of the software system in the design phase, the formal verification method has been developed, such as model checking. However, one of the challenges in the complex systems is that it is impractical to search the exhaustively scenarios as to detect the unreachable path, or deadlock of these complex systems.

Numerous studies were proposed to transform the business models or UML models into the corresponding formal models and to enable the formal verification as to ensure the validity of their behaviors using LTL model checking. For example, (Deesukying, J., & Vatanawood, W., 2016) formalized the business rules in the business model into the chunk of colored Petri nets using CPN ML functions. (Maneerat, N., & Vatanawood, W., 2016) formally mapped the UML activity diagram in colored Petri nets. (Meghzili *et al.*, 2017) demonstrated the transforming of the UML state machine diagram into colored Petri nets using Isabelle/HOL. Several researches exploited the original Petri nets such as (Rocha, J. I. *et al.*, 2011) which proposed the dataflow model property verification using Petri nets.

For the flowchart, (Gulati, U., & Vatanawood, W., 2019) proposed a set of mapping rules to convert a basic flowchart into a colored Petri net including the types of colors of the tokens and their firing functions. In short, both data flow and basic control flow of the flowchart were concerned in order to visualize all changing states of all variables specified in the flowchart. In this paper, we propose the alternative transforming of the flowchart with the nested structures into hierarchical coloured Petri nets. The nested-if or nested-loop would be mapped into an appropriate hierarchical submodule within the outermost hierarchical coloured Petri nets.






BACKGROUND

Flowchart

A flowchart (Chapin, N., 1970) represents a program flow using a set of symbols as a graphical model that shows the conceptual procedures or processes to the software owner. It is certainly used as a well-defined tool to demonstrate a step of a system such as sequence, decision, iteration, etc. The consecutive processes of the flowchart using square boxes connected with the arrow, called flowline, demonstrate a sequence of the workflow. Flowchart is used in the design and documentation phase of the software development which helps visualize the steps of work processes to get benefits of understanding and detect any problem in advance.

A simple flowchart consists of various symbols such as process, decision, and flowline (connected arrow) are shown in Table 1. Moreover, there are more symbols according to ANSI standard. In this paper, only basic symbols as shown in Table 1 are focused.

Table 1: The commonly used symbols in software documentation

Symbol	Name	Description
	Terminal	Represent the start and the end of the program
	Flowline	Represent the order of the program which indicates the sequences of the symbols
	Process	Represent the data transformation, data movement and logic operations
	Decision	Represent the decision of the program. This symbol makes 2 outputs by condition true or false
	Connector	Represent point of connection from other elements

Coloured Petri Nets

A coloured Petri net (Jensen, K., 1994) is developed using high level language to extend the ability to distinguish the data types of tokens called coloured set and explicitly embedded the user-defined functionality written in CPN ML source codes. For the complex system with both data flow and control flow, a coloured Petri net would be able to capture the dynamic properties of both data and control flows using coloured tokens and the Petri net’s control constructs. The CPN tool (Michael Westergaard and H.M.W. (Eric) Verbeek, 2015) has been developed to support the simulation and verification of coloured Petri nets. Moreover, in the CPN tool, the inscriptions which are the various labels, guards, conditions and user-defined function written in CPN ML programming language would be exploited to demonstrate the complex behaviors of the system. The various types of inscriptions are shown in Table 2. In our transforming approach, several inscriptions, such as guard inscription, code segment inscription, and initial marking inscription would be focused in order to represent the nested structures, nested-if and nested-loop, specified in a given flowchart.

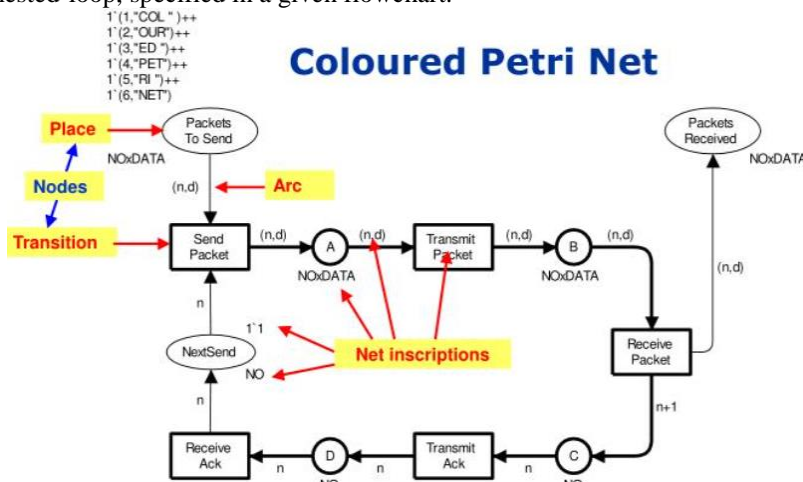


Figure 1: A sample of coloured Petri net components (Jensen, K., & Kristensen, L. M., 2009)

Table 2: Various Inscriptions of a coloured Petri net

Inscription	Name	Description
Transition	Transition Name Inscription	The label characters for state space tool
	Guard Inscription	The Boolean condition for expression
	Time Inscription	Using an @ symbol to delay expression
	Code Segment Inscription	The template to define the pattern for transition, consist of input (optional), output (optional), and code action (mandatory)
	Priority Inscription	The order of transition. (Should be non-negative integer expression)
Place	Color Set Inscription	The types of color set
	Initial Marking Inscription	The default value of place
	Place Name Inscription	The label name for place
Arc	Arc Inscription	The connection for place or transition, can be declare with single or multi element. It can declare Arc-Delay with time color set

Hierarchical coloured Petri nets

For a complex software system, a formal model written in coloured Petri nets would commonly appear with the huge numbers of places and transitions and it would be difficult to understand. In CPN tool, hierarchical coloured Petri nets have been proposed to collapse a chunk of related places and transitions into submodule and replace this chunk with double lined rectangle to reduce the complexity of the original model. This hierarchy concept is a modelling technique that separates nets into a set of submodules which provide us to manage the complexity with level of abstraction.

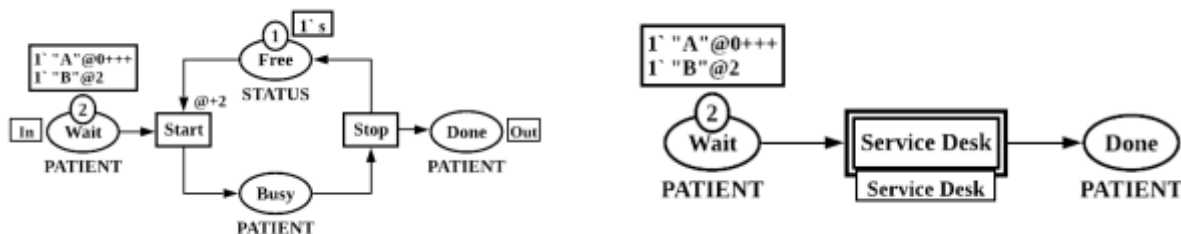


Figure 2: Service Desk module and Patient punch card module (Wil Van Der Aalst, M. P., & Stahl, C., 2011)

In Figure 2, the original coloured Petri net with non-hierarchy is shown on the left-hand side. Using the hierarchy concept, a chunk of places and transitions – transitions called Start and Stop, places called Free and Busy and their inscriptions, is collapsed into a separate submodule called Service Desk as shown on the right-hand side of the figure. Apparently, the new hierarchical coloured Petri net is more understandable and the submodule would be expanded as needed later.

The Service Desk tag below the Service Desk substitution transition is called substitution tag that shows the name of the submodule and, furthermore, inside it contains input place called input socket and output place called output socket. Then it needs to specify the substitution transition to complete the hierarchical coloured Petri nets for related interface of submodule. All can be done with port-socket relation which automatically assigns port place, input-output port, and substitution transition accordingly (Jensen, K., & Kristensen, L. M., 2009).

TRANSFORMATION APPROACH

In this section, our transformation approach is described, and a set of mapping rules are presented in order to demonstrate the transforming of the symbols in flowchart into the corresponding chunks of places and their connecting transitions along with the mandatory inscriptions labelled in the resulting hierarchical coloured Petri nets.

Our approach begins with the importing of the original complex flowchart with nested structures – nested-if and nested-loop. However, we assume that the flowchart would be drawn in some specific steps. Firstly, the single initialization process symbol which defines all the necessary variables in the flowchart would be immediately drawn after the start symbol. Secondly, before each nested structure, there exists an index initialization process symbol. For example, the flowchart with two nested-loops is shown in Figure 3 and we can see that the system variable named “array” is defined in the initialization process symbol right after the start symbol. For the nested structures, an index initialization process symbol for this outermost nested-loop named “j=1” is drawn.

The original flowchart would be considered and the set of mapping rules are exploited to transform the symbols in the input flowchart into the corresponding hierarchical coloured Petri nets. The mapping rules concern with the compound colour set for array data structures and using code segment inscription and hierarchy tool for the nested structures. Finally, the CPN tool is used to verify the resulting hierarchical coloured Petri nets.

Our transforming rules

The definitions of the flowchart and the hierarchical coloured Petri nets are described as follows.

Definition 1: Flowchart

A flowchart with the nested structure is formally defined as a 5-tuple $FC = (S, PR, CN, D, E)$ where:

- S is the start symbol.
- E is the end symbol.
- PR is a set of process symbols and $PR = SYSINIT \cup INDEXINIT \cup SIMPLE$, where SYSINIT is a set of system initialization process symbol, INDEXINIT is a set of nested structure index initialization process symbol and SIMPLE is a set of the simple assignment process symbol.
- CN is a set of connector symbols.
- D is a set of decision symbols.

Given a flowchart FC, each process symbol would be classified into SYSINIT, or INDEXINIT, or SIMPLE. At the moment, only one system initialization process symbol $sinit \in SYSINIT$ is expected and before each nested structure found in the flowchart, there exists an index initialization process $indinit \in INDEXINIT$.

Definition 2: hierarchical coloured Petri nets

A hierarchical coloured Petri net is formally defined as a 14-tuple $HCPN = (P, T, A, \Sigma, C, G, IM, V, L, CSEG, PT, HI, HO, TSUBM)$ where:

- P is a finite set of places.
 - T is a finite set of transitions such that $P \cap T = \emptyset$.
 - $A \subseteq P \times T \cup T \times P$ is a set of directed arcs.
 - Σ is a finite set of non-empty colour sets.
 - $C: P \rightarrow \Sigma$ is a colour set function that assigns a colour set to each place.
 - $G: T \rightarrow EXPRV$ is a guard function that assigns a guard to each transition t such that $Type[G(t)] = Bool$.
 - IM is the initial marking.
 - V is a finite set of typed variables such that $Type[v] \in \Sigma$ for all variables $v \in V$.
 - L is a finite set of List variable such that $L \in V$.
 - $CSEG: T \rightarrow CODE$ is a code segment function that assigns a code segment inscription $cs \in CODE$ to each transition t where $CODE$ is the set of code segment inscription.
 - $PT: Pport \rightarrow \{IN, OUT, I/O\}$ is a port type function that assigns a port type to each port place $pp \in Pport$ where $Pport \subseteq P$.
 - HI is a finite set of input port place such that $PT(pp) = IN$ where pp is a port place.
 - HO is a finite set of output port place such that $PT(pp) = OUT$ where pp is a port place.
 - $TSUBM \subseteq T$ is a set of substitution transitions where $tsub \in TSUBM$ is a double line rectangle representing a submodule in the HCPN. A chunk of subnets of HCPN would be hidden within this submodule $tsub$.
- Given an input flowchart FC to be transformed into an output hierarchical coloured Petri nets HCPN, our mapping rules are shown as follow.

Rule 1: Mapping start symbol

A start symbol s in flowchart FC would be mapped to an initial place $p \in P$ called “start” connected to a transition $t \in T$ in HCPN.

Rule 2: Mapping system initialization process symbol

A system initialization process symbol $sinit \in SYSINIT$ which is immediately appeared after the start symbol s in flowchart FC would be mapped to a place $p \in P$ connected to a transition $t \in T$. All variables declared in the system initialization process symbol $sinit$ would be collected and declared as the initial marking IM assigned in the initial place called “start”.

Rule 3: Mapping nested structure

If a nested structure index initialization process symbol $nindex \in INDEX$ is detected in the give flowchart FC , the whole body of the nested structure in the flowchart FC would be mapped into a substitution transition $tsub \in TSUBM$ as a submodule using double line rectangle symbol in HCPN. Both $hi \in HI$ and $ho \in HO$ would be created inside the submodule as the input port place and output port place respectively in order to locate the entry and exit points of the mentioned submodule/substitution transition $tsub \in TSUBM$ using port-socket concept of the hierarchical coloured Petri nets. In this submodule $tsub$, a transition $t \in T$ is created and connected to the input port place $hi \in HI$ and a code segment inscription $CSEG(t)=code \in CODE$ is assigned where $code \in CODE$ describes how to handle the nested structure index.

For example, a nested structure initialization process symbol named “ $j=1$ ” is detected in the flowchart in Figure 3. According to this mapping rule, a substitution transition or submodule is created named “New Subpage” for the output hierarchical coloured Petri net as shown in Figure 4. The nested structure of flowchart is then mapped into the corresponding submodule of hierarchical coloured Petri net in Figure 5, where the input port place called “P3” and the output port place called “P4” are created and a transition named “TS1” is also created connected to the input port place named “P3”. The code segment handling the index j is assigned to the transition “TS1” as shown in Figure 5.

Rule 4: Mapping simple process symbol

A simple process symbol $pr \in SIMPLE$ typically described the assignment statement of the system variables for the common calculation of the software system apart from the initialization process of the system variables and nested structure indexes. The simple process symbol pr would be mapped to a place $p \in P$ connected to a transition $t \in T$. Any assignment statement in the process symbol pr would be converted into code segment inscriptions as well and assigned to the transaction t as $CSEG(t) = code \in CODE$ where the code is written in the following format – input, output, action. For example, a simple process symbol named “ $i++$ ” of the flowchart in Figure 3 would be mapped to a place called “P5” and a transition called “T5” with code segment inscription.

Rule 5: Mapping a connector symbol

A connector symbol $conn \in CN$ in flowchart FC would be mapped into place $p \in P$ connected from the previous transition $t \in T$ (if any). If there exist more than one previous transitions the place p would be connected from all of the previous transitions as well. For example, a connector following the process symbol named “ $i=1$ ” in the flowchart shown in Figure 3, would be mapped into a place called “CN1” in the hierarchical coloured Petri nets shown in Figure 4.

Rule 6: Mapping a decision symbol

A decision symbol $d \in D$ in flowchart FC would be mapped into two transitions $t1$, and $t2 \in T$, where $t1$ is expected to fire if the decision is True while the transition $t2$ is expected to fire if the decision is False. The transition $t1$ would be assigned with the guard function $G(t1)$ according to the original condition written in the decision symbol $d \in D$. Whilst, the transition $t2$ would be assigned with the guard function $G(t2)$ according to the negation of the mentioned original condition. Then, each transition would be added with an arc as to be ready for the next rules.

For example, a decision symbol named “ $i < N$ ” in the flowchart as shown in Figure 3, would be mapped to the transition GT1, and GF1 where the transition GT1 is expected to fire if “ $i < N$ ” is True while the transition GF1 is expected to fire if “ $i < N$ ” is False.

Rule 7: Mapping end symbol

An end symbol $e \in E$ in flowchart FC would be mapped into place $p \in P$ called “End” connected to the previous transition $t \in T$. In our approach, only single end symbol is expected for the strictly well-formed style of the flowchart.

CASE STUDY AND TOOL OVERVIEW**Bubble Sort**

Bubble Sort is the array sorting algorithm which is working by swapping the member of the array in the current position with the next position by ascending or descending order and repeat the process until reach $N-1$ (N is the amount of the member of the array). The flowchart of the bubble sort is shown in Figure 3.

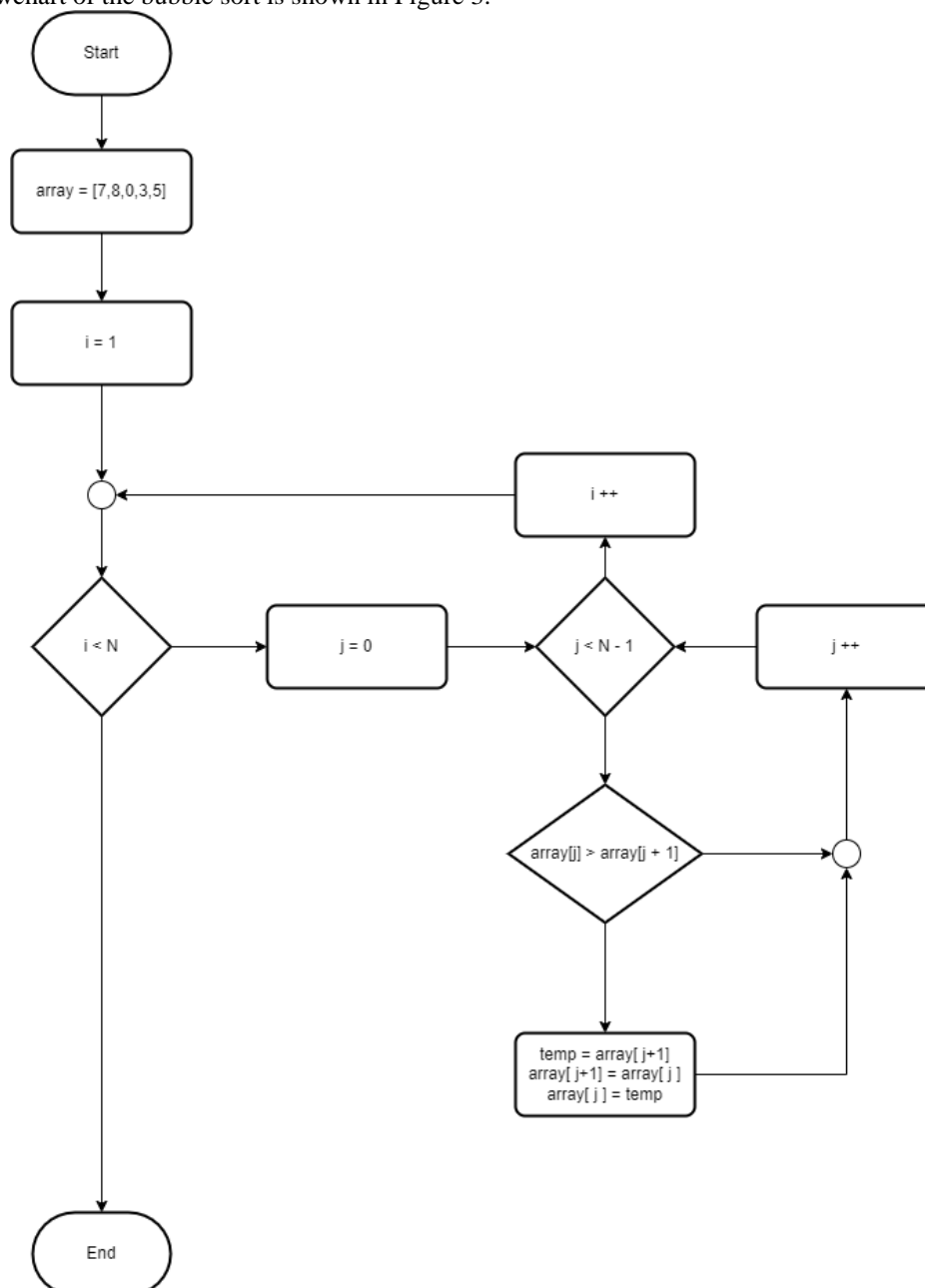


Figure 3: A flowchart created from bubble sort algorithm

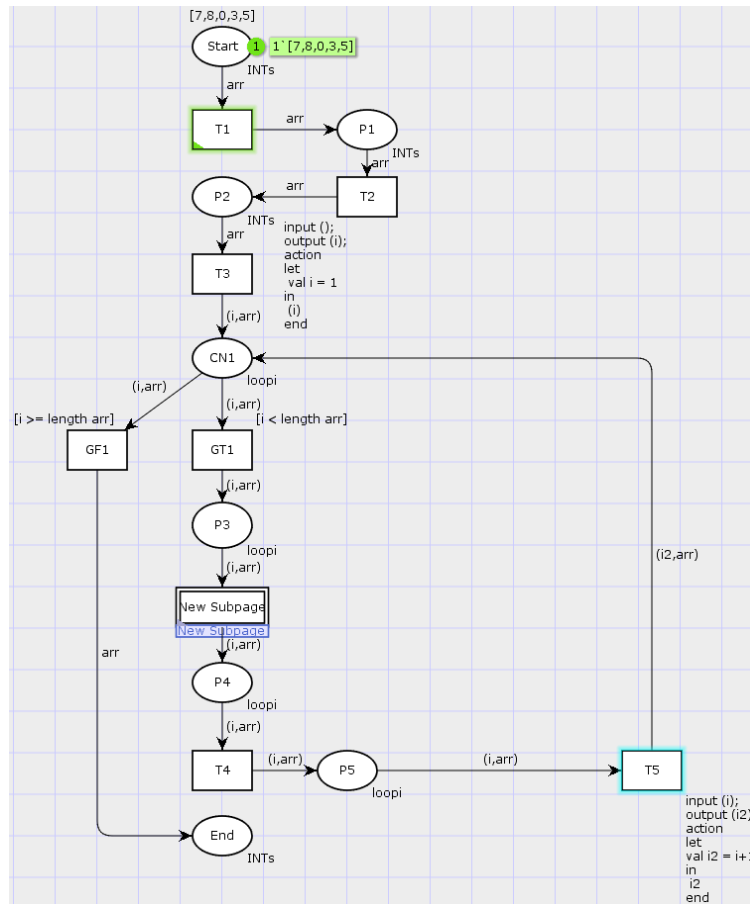


Figure 4: Loop i in bubble sort algorithm

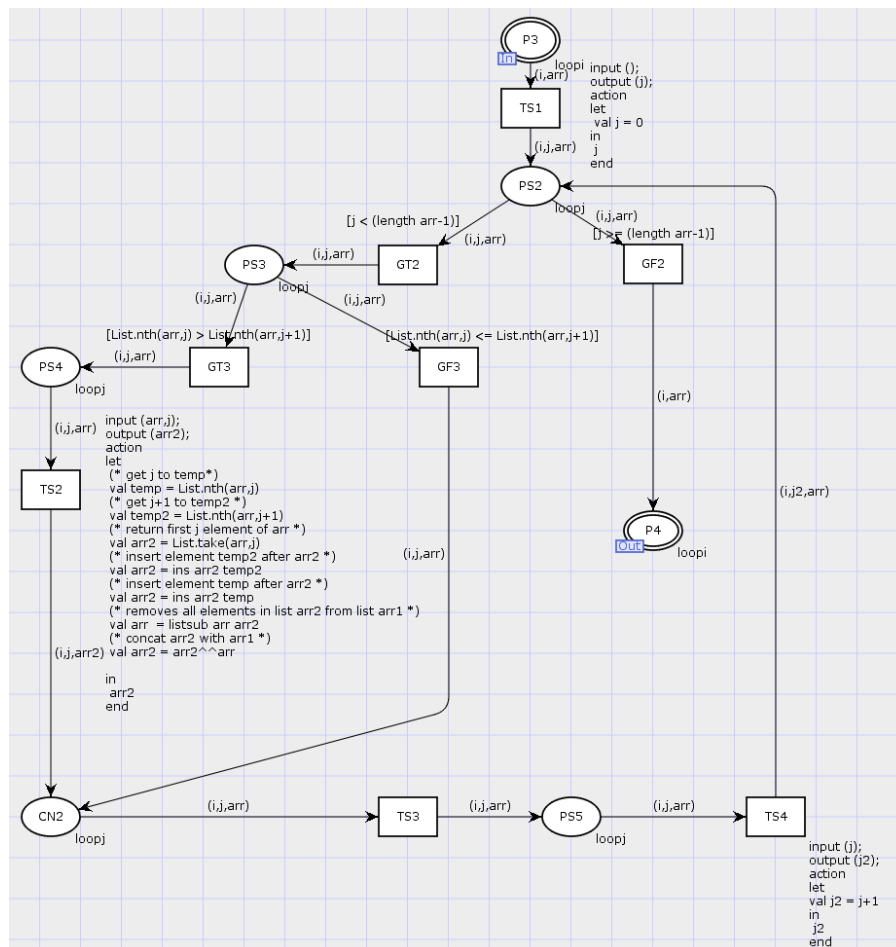


Figure 5: Loop j in bubble sort algorithm

Given a flowchart of bubble sort algorithm as shown in Figure 3, the corresponding hierarchical coloured Petri nets is transformed using our mentioned mapping rules. The highest level of net or main page is shown in Figure 4 and the lower level net of the submodule called “New Subpage” is shown in Figure 5. According to our mapping rules, the nested loop in the flowchart would be replaced with a submodule called “New Subpage”. The CPN tool is used to simulate and verify our hierarchical coloured Petri nets in Figure 4 and 5.

Firstly, the simulation shows us that the hierarchical coloured Petri nets are able to fire a token in comparable with the behaviors of the original flowchart of the bubble sort. Secondly, there are no unreachable places and transitions founded which means the mapping rules are sufficient. Thirdly, the value of the array to be sorted would be observable and correctly sorted after the simulation. The result of the bubble sort algorithm is shown in Figure 6 which appear as the array = [0,3,5,7,8].

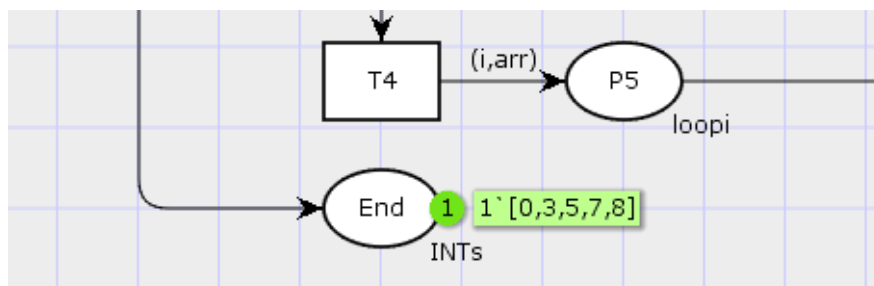


Figure 6: result of bubble sort algorithm

CONCLUSION AND FUTURE WORK

In this paper, we propose an alternative transformation approach to convert a given complex flowchart with nested structures into the corresponding hierarchical coloured Petri nets using a set of mapping rules. In our transformation approach, the nested structure index is declared and handled locally using code segment inscriptions within the submodule in order to avoid the huge number of the global variable declaration. Both bubble sort and selection sort algorithms are used as our case studies to demonstrate the nested structure. The CPN tool is used to simulate and verify the correctness and the consistency of the system behaviors between the original flowchart and the output hierarchical coloured Petri nets. Moreover, the simulation shows both data flow and control flow of the original flowchart so that the changing states or values of all variables could be observed and traced step-by-step.

However, some limitations still exist for the future works. For example, the colour sets of the coloured Petri nets are focused only on boolean, integer, list, and character. The flowchart drawing style is assumed to have the system initialization process, nested structure index initialization process being classified.

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Understanding donation intention in live-streaming from dedication and constraint perspectives

(Work-in-Progress)

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ABSTRACT

The pervasiveness of live-streaming, especially in the period of Covid-19, has brought ample monetizing opportunities for content creators through viewers' donation. Given that donation is commonly driven by the gained benefits to the donors, voluntary donation in live-streaming is still unstable due to the lack of constraints. Drawing on the dedication-constraint framework, we examined how streamer-viewer interactions, motivational feedback and self-regulation deficiency affect viewers' donation intention in live-streaming. A survey was conducted among live-streaming users in Taiwan, and the collected data were analyzed by partial least squares. The findings show that the motivational feedback (dedication-based mechanism) has a stronger influence than self-regulation deficiency (constraint-based mechanism) in determining viewers' donation intention. Responsiveness is proven as the most important interaction-based antecedent of motivation feedback and self-regulation deficiency, beside personalization and entertainment. In sum, our empirical findings have significant implications for research and practice to deepen the understanding of donation, encourage viewers to donate and maintain the relationship with content creators in live-streaming communities.

Keywords: Donation, live-streaming, interaction, dedication, constraint.

INTRODUCTION

Live-streaming has been gaining in popularity, especially in the COVID-19 pandemic. The pandemic positively impacted the live-streaming market with a massive increase in the usage of live-streaming services and platforms among various industries. For example, music artists keep performing through live concerts while gamers increase their live game-streaming time to reach viewers who were experiencing their social-distancing period. The habit of watching live-streaming is still kept until now, and live-streaming has become a lucrative profession for content creators. This is because streamers can exploit various revenue affordances in live-streaming (e.g., Twitch, YouTube Live, Facebook Live and YY Live), such as advertisement, subscription and donation from viewers, in which donation has become more popular and important. Donation becomes more and more popular when YY Live (China) acquired \$905.7 million from donations in the third quarter of 2019 (YYInc, 2019). However, drawing on the donation literature, donation has been largely studied as a charitable practice, not a way to show their appreciation (Wan et al., 2017), through which streamers and viewers can tighten the mutual relationship. Besides, existing donation-related studies have concentrated on the benefits to the self, such as seeking satisfaction or monetary aspirations (Ye et al., 2015). We argue that donation driven by benefits gained from streamers' service is inadequate, as viewers could find even-better benefits from other streamers (e.g., having more interesting content and greater streaming skills). Viewers bear no constraints to voluntarily donate and stick with the current streamers. Hence, present researchers' attention to the importance of constraint to donation outcomes is limited. Thereby, we opt to use the dedication-constraint framework to fully comprehend the formation of donating intention.

Prior work on live-streaming frequently relies on a social-technical viewpoint to investigate donation behaviors (Hou et al., 2021; Wan et al., 2017). However, there has not been much effort put into researching the unique aspect of live-streaming that is the streamer-viewer interaction in real-time, through which viewers experience the benefits and costs. There is a need to advance extant literature by developing and testing a model that includes the human-interaction approach to stimulate donation intention in live-streaming. Thereby, the following research questions will be addressed in this study:

RQ1. How do conceptualized dedication-constraint factors affect viewers' donation intention?

RQ2. How does streamer-viewer interaction affect dedication-based and constraint-based factors?

This study draws on dedication-constraint framework to enhance the understanding about donation outcome, and it makes the following key contributions. First, we broaden our present knowledge of donations to content creators. Specifically, beside the conceptualization of dedication (i.e., motivation feedback), we examine self-regulation deficiency as constraint-based reactions

generated from a history of interacting with streamers. Second, this research responds to recent calls for increased use of dual-system models to completely characterize IS usage behavior in general and promote donation practices in live-streaming in specific. Third, we expand our understanding of the process of streamer-viewer interaction, from which content creators may build a coordinated plan to attract viewers, provide a good interacting experience, and direct viewers to donation with the aims of maintaining relationship with content creators, consequently fostering the development of the live-streaming community.

BACKGROUND

Live streaming, interaction and donation intention

Live streaming is a revolutionary method of recording and streaming in real time (Xue et al., 2020). Live-streaming provides more effective real-time interactivity and streamer-viewer connectivity than pre-recorded videos uploaded on YouTube. For example, the real-time interactivity allows streamers to instantly answer and explain viewers’ doubts and questions, through which viewers may perceive the live-streaming interaction quality regarding personalization, responsiveness and entertainment (Xue et al., 2020). Moreover, live-streaming platforms provide donation-supported tools, including donation notification, donation link, top donors list, and importantly, “top donor” announcement can give streamers a strong sense of social status (Sjöblom et al., 2019). Besides, donation as a revenue stream can encourage streamers to create high-quality content to viewers (Hou et al., 2021) Therefore, donation is a critical engagement behavior leading to the success of live-streaming.

Previous research has investigated donation behavior using socio-psychological theory. This stream of work mainly bases on benefit-driven motivations from individual, live-streaming feature-related, social, cultural stimuli to identify viewers’ voluntary donation. For instance, Wan et al. (2017) draws on emotional attachment theory that has significant motivational and behavioral implication, to understand the link between reactions to social-technical stimuli and readiness to donation. Although useful, motivational feedback approach may not fully explain the donation in live-streaming. In this study, we explore the impacts of streamer-viewer interactions on donation intention using the integrated view of motivational feedback (dedication-based) and self-regulation deficiency (constraint-based).

The conceptual dedication-constraint model

According to social exchange theory, dedication-constraint model includes two mechanisms that support the development of long-term relationships between customers and service providers (Bendapudi and Berry, 1997). Dedication is described as a person’s desire to continue relationships in the prospect of gaining long-term mutual benefits (Kim and Son, 2009). Constraint mechanism refers to the economic, social, or psychological investments that keep people in their current relationships (Kim and Son, 2009). Unlike prior work, we conceptualize dedication-based mechanisms as motivational feedback (affective feedback and social feedback), and the constraint-based as self-regulation deficiency (cognitive preoccupation and behavioral compulsion). In terms of antecedents of the dedication-constraint model, when focusing on the uniqueness of live-streaming, we decide to examine three dimensions of real-time interactivity, including personalization, responsiveness and entertainment.

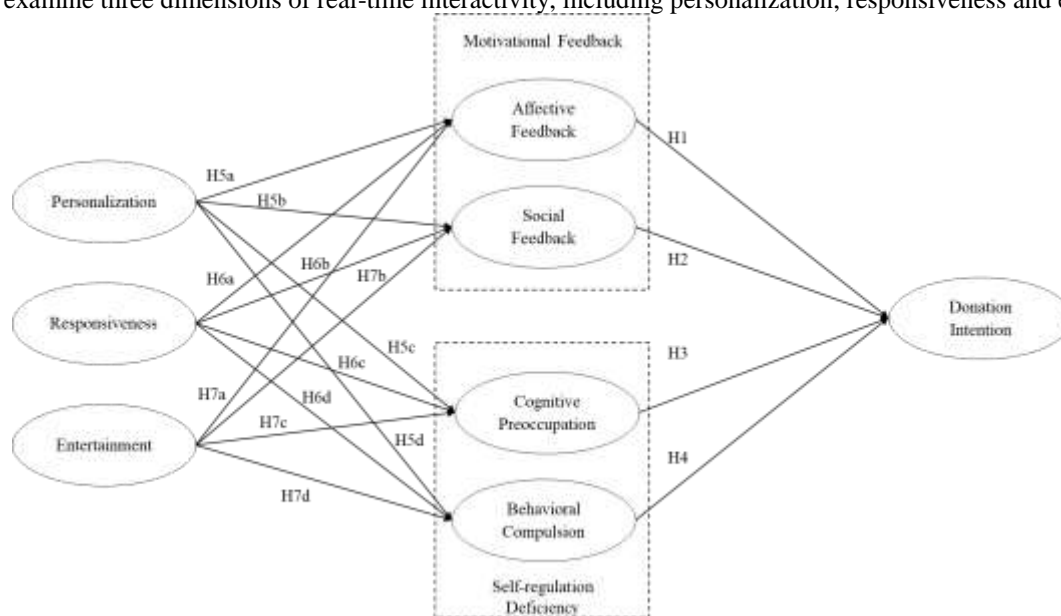


Figure 1: Research model

HYPOTHESIS DEVELOPMENT

Hypotheses between motivational feedback, self-regulation deficiency and donation intention

Motivation is used in this work as a conceptualization of dedication-based mechanism to analyze the donation intention, as motivation focuses on perceived benefits from favorable experience. Bendapudi and Berry (1997) indicated feedback to initial motivation generated from perceived benefits (based on one’s consumption experience) will in turn drive one’s decision-making to perform specific behaviors for the purpose of maintaining relationships with partners (e.g., through continued use or loyalty). In the live-streaming, when viewers perceive benefits (e.g., good personalized, responsive and entertaining experience)

from the interactions with streamers, they will have motivational feedback towards donation intention to prolong the relationship with streamers. Otherwise, motivational feedback is represented by affective feedback and social feedback (Hassan et al., 2019).

H1: Affective feedback has a positive effect on viewers' donation intention.

H2: Social feedback has a positive effect on viewers' donation intention.

Prior research has recognized the importance of the constraint mechanism in studying post-adoption behaviors, and it has been referred to as switching costs (Kim and Son, 2009). We argue that the streamer's quality and performance are artificial switching costs that cannot transfer to other streamers, making it difficult for viewers to find the same-quality streamer in a short period of time and end up continuing the relationship. In the present research, we emphasize the role of self-regulation towards the costs. When the stimulus is enormously huge, no self-regulatory capacity can restrain it, implying the self-regulation deficiency against these constraints (Liu et al., 2020). In live-streaming context, viewers are preoccupied with these constraints (self-regulation deficiency) and do not want to discontinue their present live-streaming connections with streamers. They are more likely to perform particular actions (e.g., donations) to continue interacting and consuming high-quality content, leading to the impacts of two dimensions of self-regulation deficiency (cognitive preoccupation and behavioral compulsion) on donation intention.

H3: Cognitive preoccupation has a positive effect on viewers' donation intention.

H4: Behavioral compulsion has a positive effect on viewers' donation intention.

Hypotheses between interactions and dedication-constraint model representatives

Personalization measures how well the given material matches the preferences and needs of the users (Xue et al., 2020). Franke and Schreier (2010) claimed that the perceived preference fit from self-designed items promotes customer' delight. Personalized suggestions or one-of-a-kind offers in social commerce provide users a high sense of social support (Liang et al., 2011). Personalized content is simpler to recall, thus processing relevant information requires greater cognitive effort as the specificity of goals broadens (Tam and Ho, 2006). Moreover, since personalized content is more attentive than the irrelevant, it steers viewers around flow experience, leading to compulsive symptoms (Chen et al., 2017).

In the live-streaming context, personalization describes the streamers' ability of tailoring the content that fits viewers' preference and personal need. This definitely makes viewers enjoyable and feel connected to live-streaming communities, leading to H5a and H5b. On the other hand, the easy-to-recall personalized content is more likely to live in viewers' mind and make them addicted to even conduct compulsive behaviors- H6d.

H5a: Personalization has a positive effect on affective feedback.

H5b: Personalization has a positive effect on social feedback.

H5c: Personalization has a positive effect on cognitive preoccupation.

H5d: Personalization has a positive effect on behavioral compulsion.

The term "responsiveness" describes how quickly media platforms respond to users' query (Xue et al., 2020). Responsiveness in an online interaction shows a fairness in social exchange that makes users satisfied for the time spent and feel recognized (Xue et al., 2020). Besides, Wu (2019) and Speckens et al. (2007) found that interactive websites can make users more involved in communications and use cognitive efforts to process information, accidentally eliciting the mental imagery and obsessive compulsive symptoms.

In live-streaming, responsiveness refers to how fast and efficiently streamers offer response to viewers. In an effort of spending time in live-streaming and seeking answers, viewers might have positive emotional responses for responsive answers, and feel that their participation is recognized by other participants, leading to H6a, H6b. Otherwise, viewers may often recall the images of how responsively streamers interact with them and these overwhelming cognitive efforts will make viewer's minds preoccupied, and it is hard to restrain their urge to have more interactions with streamers, leading to H6c and H6d.

H6a: Responsiveness has a positive effect on affective feedback.

H6b: Responsiveness has a positive effect on social feedback.

H6c: Responsiveness has a positive effect on cognitive preoccupation.

H6d: Responsiveness has a positive effect on behavioral compulsion.

Entertainment is the pleasure one objectively has when engaging in a particular behavior or activity (Xue et al., 2020). Entertainment from interactions is proven as a facilitator of social ties, connectivity, and friendship (Hsieh and Tseng, 2017). However, these hedonic benefits are found to limit the ability to regulate time spent on those platforms, causing the maladaptive cognitions and compulsive behavior (Japutra and Song, 2020; Osatuyi and Turel, 2018).

In the live-streaming, viewers may feel pleasant, satisfied, and free to socialize with others through funny moments of interacting with streaming, leading to positive feedback both emotionally and socially- proposing H7a and H7b. The amusing

moments are hard to completely erase, but constantly revolve in viewers' mind, causing the cognitive preoccupation and even drive the viewers' behavioral compulsion, urging more interactions– leading to H7c and H7d.

H7a: Entertainment has a positive effect on affective feedback.

H7b: Entertainment has a positive effect on social feedback.

H7c: Entertainment has a positive effect on cognitive preoccupation.

H7d: Entertainment has a positive effect on behavioral compulsion.

METHODOLOGY

Data was collected in Taiwan that has high proportions of live-streaming awareness and usage to test the research model. We distributed the questionnaire via online channels to reach the target respondents who are users of Twitch, YouTube Live and Facebook Live. Data-collecting procedure was conducted under the longitudinal approach. At stage I, we used the several items in the questionnaire to measure the interactivity-related antecedents and factors of dedication-constraint model factors. The stage II was implemented two weeks later to assess donation intention via the remaining items. There were 300 questionnaires sent out, and 208 samples used for official data analysis, in which 109 of them are males (52.4%) and the 18-25 age group account for the largest percentage of 58.1%.

The measurement items were evaluated adopting a seven-point Likert scale, ranging from 1 (completely disagree) to 7 (completely agree). Four items used to measure donation intention were adapted from Ye et al. (2015). Four items each measuring affective feedback social feedback were developed from Hassan et al. (2019). Four items each measuring cognitive preoccupation and behavioral compulsion were adapted from Haagsma et al. (2013). Personalization, responsiveness and entertainment (3 items each) was developed from Xue et al. (2020).

Partial Least Squares Structural Equation Modeling (PLS-SEM) was used as the primary data analysis approach in this study. PLS-SEM was used because it is appropriate to examine the path coefficients between the latent variables of structural models (Hair Jr et al., 2021), and it does not require large sample sizes or assumptions about data distributions (Pavlou and Fygenon, 2006). We followed the two-step approach (Anderson and Gerbing, 1988) to examine both the measurement (outer) model and structural (inner) model. The SmartPLS software, version 3.3.3, was used for data analysis.

RESULT

Common method biases and Measurement model

Harman's single factor test was employed, and findings show that the first factor' variance constitutes only 39.26% of the total variance that is lower than the benchmark of 50% (Podsakoff et al., 2012). We assessed the measurement model via its reliability and validity (Henseler, 2017). The results shown in Table 1 and Table 2 confirm the good reliability, convergent and discriminant validity. Besides, multicollinearity is not a significant issue in our study that is evidenced by using variance inflation factor (VIF) values (1.381 to 2.545), lower than the cut-off value of 5.0 (Hair Jr et al., 2021).

Table 1: Results of reliability and AVE.

Constructs	Items	Cronbach's alpha	Composite Reliability	Average Variance Extracted
Personalization	PE	0.794	0.879	0.708
Responsiveness	RE	0.856	0.912	0.776
Entertainment	EN	0.874	0.922	0.798
Affective Feedback	AF	0.869	0.911	0.718
Social Feedback	SF	0.847	0.898	0.689
Cognitive Preoccupation	CP	0.899	0.929	0.767
Behavioral Compulsion	BC	0.862	0.906	0.707
Donation Intention	DI	0.879	0.917	0.733

Source: This study.

Table 2: Descriptive statistics and correlation among constructs.

	Mean	SD	PE	RE	EN	AF	SF	CP	BC	DI
PE	4.742	1.058	0.842							
RE	4.891	1.273	0.536	0.881						
EN	5.018	1.240	0.429	0.439	0.893					
AF	4.802	1.069	0.459	0.463	0.391	0.847				
SF	4.837	1.044	0.453	0.581	0.383	0.444	0.830			
CP	4.821	1.179	0.410	0.604	0.419	0.462	0.506	0.876		
BC	4.767	1.130	0.426	0.463	0.418	0.465	0.558	0.466	0.841	

DI 5.035 1.044 0.475 0.619 0.455 0.639 0.646 0.637 0.509 **0.856**

Note: The squares root of average variance extracted are displayed by the diagonal elements in bold.

Source: This study.

Structural model

We used the PLS-SEM and bootstrapping technique (5000 bootstrapping resamples at 95% confidence interval) to test the path coefficients and proposed hypotheses. The results are listed in Table 3 with 9 out of 12 supported hypotheses. Findings show R-square values for donation intention (64.7%), affective feedback (29.9%), social feedback (37.6%), cognitive preoccupation (39.7%), and behavioral compulsion (29.5%). Additionally, all control variables exert no significant impact on the dependent variable (donation intention).

Table 3: The path coefficients of research model.

		Coefficient	t-value	Result
H1	AF -> DI	0.331***	5.231	Supported
H2	SF -> DI	0.319***	5.037	Supported
H3	CP -> DI	0.289***	5.136	Supported
H4	BC -> DI	0.018 ^{N.S.}	0.305	Not supported
H5a	PE -> AF	0.248**	3.298	Supported
H5b	PE -> SF	0.167**	2.638	Supported
H5c	PE -> CP	0.074 ^{N.S.}	1.199	Not supported
H5d	PE -> BC	0.190*	2.396	Supported
H6a	RE -> AF	0.255**	3.444	Supported
H6b	RE -> SF	0.439***	6.030	Supported
H6c	RE -> CP	0.488***	8.065	Supported
H6d	RE -> BC	0.264**	3.272	Supported
H7a	EN -> AF	0.173*	2.295	Supported
H7b	EN -> SF	0.119 ^{N.S.}	1.806	Not supported
H7c	EN -> CP	0.173*	2.548	Supported
H7d	EN -> BC	0.220**	2.921	Supported

Note: *p<0.05; **p<0.01; ***p<0.001; NS, non-significant

Source: This study.

CONCLUSION: DISCUSSION, IMPLICATIONS, FUTURE WORK

Our findings confirm that the characterization of motivational feedback (dedication-based) and self-regulation deficiency (constraint-based) as corresponding reactions for interaction-based stimuli properly analyzes the mechanisms of donation intention, demonstrating persuasive evidence to consolidate our theoretical arguments above. First, motivational feedback (i.e., dedication-based mechanism) plays a stronger predicting role than self-regulation deficiency (i.e., constraint-based mechanism) for viewers' subsequent donation intention. This implies that viewers are more likely to form their intention of donating to streamers by perceiving current values of interactions with streamers. Regarding the relationships between streamer-viewer interactions and representatives of dedication-constraint mechanisms, responsiveness is the most important, with all four supported hypotheses. This finding is pertinent, because responsiveness is the best demonstration of the live-streaming success (i.e., real-time interactivity).

Our study contributes to theory by combining the conceptualized dedication-constraint framework with the key of live-streaming (streamer-viewer interaction) and explaining the viewer's donation intention. This study fills a gap in the donation literature by exposing the shortcomings of the benefit-oriented approach only and providing insight into the powerful effects of the constraint-based. Furthermore, the application of the dedication-constraint model enriches the existing empirical study employing dual-systems to provide a comprehensive knowledge of IS behavior, including reflective-reflexive dual system (Gong et al., 2019), conscious and unconscious response (Nguyen et al., 2022), promotion-prevention approach (Ye et al., 2015). Besides, this study advances dedication-constraint literature by expanding the applicability to a totally new online context (live-streaming) but also its conceptualization and measurement, becoming a premise encouraging the innovative conceptualization and application.

Besides, our empirical study provides fresh insights into the live-streaming interaction antecedents of donation intention, emphasizing the importance of personalization, responsiveness and entertainment in practice. Streamers should proactively predict the viewers' preferred topics, then deliver content that responsively solves their personal needs and create entertaining moments. This encourages viewers to donate to content creators, motivating them to create more high-quality content, contributing to the streamer-viewer relationship and the development of live-streaming communities overall.

Our research has several limitations and future research. First, the follow-up study should be internationally conducted to reduce the cultural bias because live-streaming seems more popular in Eastern countries. Second, in order to avoid the limited

conceptualization for a specific context, future studies should extend the dedication-constraint conceptualization to more insightfully explain donation intention in various online settings.

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Understanding the service gap between caregivers and recipients in the smart bed system

(Work-in-Progress)

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ABSTRACT

With the advancement of medical technologies and low birth rates, the world's elderly population has risen sharply, and the aging society has increased more and more medical demand. Thus, how to provide a quality home care service is critical. To provide quality care, understanding the needs of the service system's users is an important step. This research aims to identify the gaps in service needs as expected between two types of system users – caregivers and recipients. The Internet of things (IoT) based smart-bed system developed by H Company was adopted as the research object. Caregivers and recipients were asked to fill in an analytic-hierarchy-process (AHP) questionnaire to rank the importance of smart-bed system functions. In current stage, this study finds that caregivers and recipients consider the forewarning function the most important. For care recipients, functions related to physical sensations (e.g., data analysis on detailed sleeping behaviors) are more important. While for caregivers, functions that can improve their work efficiency and quality (e.g., customized data reporting) are more important. While caregivers concern more about how to complete their tasks, care recipients value more on safety and comfort of the system. Future research can study the importance of service functions and the reasons causing the gaps in order to provide valuable suggestions for IoT companies to improve their future services development and product marketing.

Keywords: analytic hierarchy process, customer journey map, smart cloud service platform, homecare, long-term care.

INTRODUCTION

With the progress of society and the improvement of health and medical standards, all countries in the world are facing the phenomenon of population aging. Due to the rapid increase in the elderly population and the prolongation of the average life expectancy of the national, the demand for long-term care is also increasing. Under the aging social structure, the care and treatment need of elderly people continue to emerge, increasing huge medical expenditures. At the same time, due to the declining birthrate, the burden of care for young and middle-aged people is also increasing. These phenomena show that Asia is facing a worry of "increasing demand for care and shortage of care manpower".

However, with the vigorous development of Information and Communication Technology (ICT) and the advancement of technologies, such as the Internet of Things, wearable devices, sensors, and artificial intelligence, information technology has gradually played a pivotal role in the field of health care, also led to the development of Telehealth Care. Through the front-end sensing device, medical cloud and service connection, smart medical integrates the data collected by IoT devices and performs big data analysis and computing, which not only helps users to achieve self-health management; caregivers can also remotely monitor the care recipients. By extending the field of care from medical institutions to homes, medical resources can be used more effectively. Therefore, how to use technology in the medical care support environment has received extensive attention, and countries have also actively introduced information and communication technology into the field of long-term care, hoping to make the elderly more humane and healthier to enjoy their old age (Haslwanter, Garschall, Neureiter, Panek, & Subasi, 2018).

The application of smart medical care in elderly care, in addition to hospitals and other medical institutions, also has great demand in home and community care. The trend of future medical care management optimization is the introduction of smart technology and the establishment of cloud services. Combining the application of home long-term care and smart cloud system, the two complement each other, can build efficient and low-cost care services, and through the long-term and continuous home care model. At present, medical care institutions at all levels have regarded the information system as a strategic information system to improve the effectiveness and quality of care and maintain a competitive advantage. However, given the general shortage of information technology manpower (Haimi & Gesser-Edelsburg, 2022), how can long-term care institutions

properly select, plan, evaluate and introduce emerging information technology and technology, and provide smart and customized health care Nursing is still a major problem and challenge for general long-term care institutions.

This study aims to understand the service gap between caregiver and recipients in telehealth care system. It takes the smart bed as a focused object. The AHP questionnaire were developed and distributed to both parties. This study is expected to finally elicit the design needs for the development of the electronic health care system, so as to provide the most suitable system service development plan in the future, so that the caregivers and the care recipients can experience the most suitable services and valued smart medical solutions.

THEORETICAL BACKGROUNDS

Telehealth Care

With the advancement of communication technology and the popularization of the Internet of Things, information technologies have gradually begun to be used in medical care, which has also led to the development of telehealth care. Telehealth care is an emerging care model that uses remote video equipment or information and communication technology to facilitate communication between caregivers and care recipients in two places, and to provide medical services. It usually adopts medical diagnosis or treatment to conduct preventive medical interventions (Demiris & Hensel, 2009). For example, seniors who do not need daily care can communicate with healthcare providers by wearing a wearable or watch. At the same time, electronic health care also provides many potential advantages and benefits, such as eliminating geographical restrictions on care services, saving costs and time, reducing hospitalization rates, and improving service quality, etc. (Mort et al., 2015).

Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) was developed by Saaty (1977), a professor at the University of Pittsburgh, USA. It is suitable for decision-making problems with multiple evaluation criteria under uncertain circumstances. It is composed of tangible and intangible, qualitative and quantitative elements that interact with each other. AHP also continues to be applied in many fields, such as medical, road design and economic decision-making problems (Irfan et al., 2022; Panchal & Shrivastava, 2022; Wang, 2022).

METHODOLOGY

This study takes telehealth care system as the research object, and uses the AHP questionnaire method to analyze the needs of home caregivers and the care recipients when they using the electronic health care system. This study particularly analyzes the importance of needs of system services including the smart-bed and other related smart medical IoT products. The AHP structure is shown in the figure below. This research uses questionnaires to cross-examine users for comparison. Each major system will have compared with each other, then we'll use Export Choice software to compute the weights of every service in order to understand the importance of service order. After making narrative statistics on the importance and weight of each system service, in-depth interviews will be conducted in the future to obtain the causes of the gaps and a more in-depth service process design.

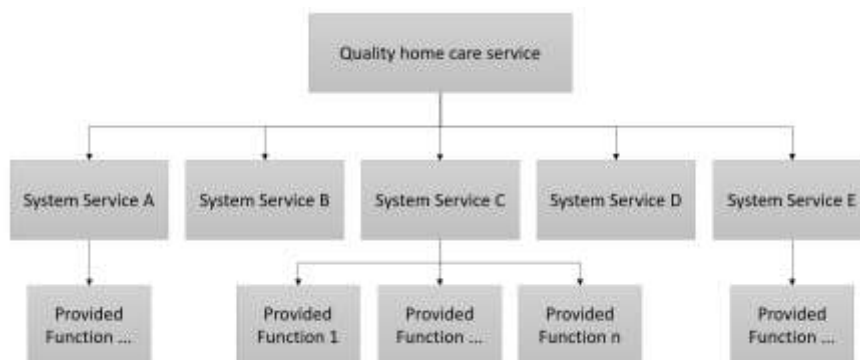


Figure 1: AHP Structure

In order to quickly provide professional medical services and real-time alerts, it is particularly important to measure the importance of both users to system functions. According to the introduction of the electronic medical care system provided by H Company, the AHP items of this research are developed and summarized into 5 major system functional areas, “A. Real-time Status”, “B. Forewarning Functions”, “C. Data Collection and Analysis”, “D. Artificial Intelligence Application”, “E. Expansion and Integration”. There are more detailed functional sub-factors under each system functions, and the sub-items are described in Table 1.

Table 1: System Functions and Sub-factors

<i>System Functions</i>	<i>Sub-factors</i>
A. Real-time Status	A1. Real-time updates of safety status A2. Diversity of real-time safety status A3. Fast updates of real-time physical sensation A4. Diverse updates of real-time physical sensation
B. Forewarning Functions	B1. Apnea time

	B2. Over-breathing times
	B3. Slow-breathing forewarning
	B4. Wake up/get out of bed warning according to the bed position
	B5. Automatically cancel the system. reminder when returning to bed
	B6. Fast reminder of wake up/get out of bed
C. Data Collection and Analysis	C1. Automatic collection of physiological data
	C2. Detailed physiological data analysis
	C3. Customized physiological data report
	C4. Automatic collection of sleep behavior data collection
	C5. Detailed sleep behavior data analysis
	C6. Customized sleep behavior data report
D. Artificial Intelligence Application	D1. Automatic record of co-formulated roll over signal
	D2. AI bed: roll-over positioned time recording
	D3. AI bed: roll-over reminder according to degree of bedsore
	D4. Automatically calibrates and adjusts to fit various medical mattresses
	D5. Automatically calibrates and adjusts to fit various electric medical mattresses
	D6. Automatic calibration and adaptation for home, community and care facilities
E. Expansion and Integration	E1. Combine with IoT to automatically control the best sleeping environment
	E2. Integrate with face recognition system for positioning
	E3. Integrate applications with other health monitoring equipment
	E4. Care voice robot combination

PREMIMINARY FINDINGS

The survey samples of this study include both the care recipient and the caregiver. A total of 53 questionnaires were collected, 23 for the care recipients and 30 for the caregivers. The 53 questionnaires were tested for consistency one by one. When the Overall Inconsistency ≥ 0.1 (and C.R. ≥ 0.1), it means that the respondents have inconsistent answers. In this case, the questionnaire will be deleted. In the end, 13 questionnaires failed to pass the consistency test, including 8 for the care recipients and 5 for the caregivers, so they were deleted. Therefore, a total of 40 valid questionnaires were finalized in this study.

Based on the results, both parties believe that the "fast updates speed of real-time security status" is a very important function. The care recipient believes that the safety status is more important than the display of diversity, because only when the update speed is fast enough, the caregiver can immediately let the caregiver know when there is an abnormality in their own condition. Caregivers believe that instant safety status is important because it helps them understand the current situation of the care recipient easily and quickly.

Table 2: AHP Result of Real-time Status

A. Real-time Status	Recipient Weights(A)	Order	Caregiver Weight(B)	Order	Difference A-B	Difference Order
A.1 Real-time updates of safety status	12.82%	1	14.27%	1	1.45%	1
A.2 Diversity of real-time safety status	8.84%	2	8.15%	2	0.69%	2
A3. Fast updates of real-time physical sensation	4.44%	3	4.56%	3	0.12%	3
A4. Diverse updates of real-time physical sensation	3.87%	4	3.85%	4	0.02%	4

According to the results, the care recipients believe that the apnea time is the most important indicator. If they are not detected and dealt with immediately, their own lives may be endangered, so they regard it as the most important indicator. The second is the over-breathing times. The care recipient thinks that breathing too fast will be uncomfortable, causing inner panic, and over-breathing usually occurs suddenly and rapidly, so they hope that the care system can remind the caregiver as soon as possible.

From a caregiver's point of view, apnea is less visible and more critical and needs to be dealt with as soon as possible, so apnea time is considered to be the most important. The second is the early warning of slow breathing. Contrary to the care recipient's belief that breathing is too fast, the caregiver thinks that the early warning of slow breathing is more important, because it may be a manifestation of poor body function or critical illness, and it is also not easy to detect, so that the warning of slow breathing is more important.

Table 3: AHP Result of Forewarning Functions

B. Forewarning Functions	Recipient Weights(A)	Order	Caregiver Weight(B)	Order	Difference A-B	Difference Order
B1. Apnea time	14.12%	1	11.97%	1	2.15%	1
B2. Over-breathing times	9.40%	2	7.38%	3	2.02%	2
B3. Slow-breathing forewarning	2.49%	4	2.80%	4	0.31%	3
B4. Wake up/get out of bed warning according to the bed position	2.15%	5	2.37%	5	0.22%	4
B5. Automatically cancel the B4. reminder when returning to bed	8.20%	3	8.26%	2	0.06%	5
B6. Fast reminder of wake up/get out of bed	2.06%	6	2.06%	6	0.00%	6

The "automatic physiological data collection" with the largest gap, caregivers think it is more important, because it can save them some care time and effort. Compared with caregivers, care recipients consider other functions to be more important, because the collection of physiological data does not directly affect the quality of care, but the analysis of the collected data is more important.

Table 4: AHP Result of Data Collection and Analysis

C. Data Collection and Analysis	Recipient Weights(A)	Order	Caregiver Weight(B)	Order	Difference A-B	Difference Order
C1. Automatic collection of physiological data	1.77%	3	3.13%	2	1.36%	1
C2. Detailed physiological data analysis	1.66%	5	2.35%	3	0.69%	2
C3. Customized physiological data report	2.98%	1	3.61%	1	0.63%	3
C4. Automatic collection of sleep behavior data collection	1.72%	4	2.33%	4	0.61%	4
C5. Detailed sleep behavior data analysis	1.14%	6	1.62%	6	0.48%	5
C6. Customized sleep behavior data report	2.67%	2	2.31%	5	0.36%	6

Both parties believe that it is an important function that the AI mattress can be reminded to turn over according to the degree of bedsores. The care recipient believes that sometimes the caregiver doesn't always remember to roll them over, so it would be great to have a rollover reminder tailored to their situation. Caregivers believe that bedsores can sometimes lead to more serious illness and sometimes forget to roll over, so it is important to have rollover reminders.

Table 5: AHP Result of Artificial Intelligent Applications

D. Artificial Intelligence Application	Recipient Weights(A)	Order	Caregiver Weight(B)	Order	Difference A-B	Difference Order
D1. Automatic record of co-formulated roll over signal	1.31%	6	2.36%	2	1.05%	1
D2. AI bed: roll-over positioned time recording	2.58%	2	1.69%	5	0.89%	2
D3. AI bed: roll-over reminder according to degree of bedsore	2.16%	4	1.73%	4	0.43%	3
D4. Automatically calibrates and adjusts to fit various medical mattresses	2.95%	1	2.58%	1	0.37%	4
D5. Automatically calibrates and adjusts to fit various electric medical mattresses	2.29%	3	1.94%	3	0.35%	5
D6. Automatic calibration and adaptation for home, community and care facilities	1.60%	5	1.47%	6	0.13%	6

The care recipients believe that if the IoT can be combined with the automatic control of the care environment, such as lighting, temperature, etc., it will not only improve the comfort of the care environment, but also reduce the caregivers' problems. Therefore, it is more important for the care recipients to "optionally combine with IoT to automatically control the optimal sleeping environment" compared to caregivers.

Table 6: AHP Result of Expansion and Integration

E. Expansion and Integration	Recipient Weights(A)	Order	Caregiver Weight(B)	Order	Difference A-B	Difference Order
E1. Optionally combine with IoT to automatically control the best sleeping environment	1.59%	2	2.73%	1	1.14%	1
E2. Optionally integrate with face recognition system for positioning	2.66%	1	2.04%	2	0.62%	2
E3. Optionally integrate applications with other health monitoring equipment	1.48%	3	1.34%	3	0.14%	3
E4. Optionally Care Voice Robot Combination	1.04%	4	1.07%	4	0.03%	4

CONCLUSION

This research has identified the service expectations from both caregivers and care recipients of telehealth care system through AHP questionnaires. We found that caregivers and care recipients have several expectation priorities in common with the system services. Yet, in terms of their major needs, we shall develop the product with satisfied functionalities to serve as a safe and ease of use system. In the future, this research will conduct more in-depth system requirements analysis and design, and develop different functions required by different users for the system, and carry out feasibility studies. Then, through the prototype method, a test system will be first established for different users to test. By further survey study, we can obtain more user feedbacks on the system prototype, and modify and optimize functions according to the results, and finally develop the actual system for the market.

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Understanding users' trust transfer mechanism in food delivery APP

(*Work-in-Progress*)

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ABSTRACT

With the rapid dissemination of mobile technologies, along with hectic life nowadays, consumers are more in favor of food delivery apps (FDA). However, many aspects related to the usage of FDAs have not been fully unearthed. Drawing upon the trust transfer theory, the study theorizes the consumer's trust formation in FDA and investigates the antecedents of trust to platform and trust to a merchant that mediates the continuous usage intention and purchase intention. The proposed framework was tested through structural equation modeling (SEM) based on an online questionnaire. The findings illustrate the trust transfer mechanism in the context of the FDA and its effects, which have both theoretical and practical implications for different stakeholders.

Keywords: Food delivery app, trust transfer theory, continuous intention.

INTRODUCTION

With the advent of mobile technologies, the prevalence of online-to-offline (O2O) commerce has created significant disruption across many industries (Xiao, Zhang, & Fu, 2019). In the hospitality sector, food delivery apps (FDA) are a sort of O2O platform that not only provides consumers with more choices of food but also offers catering providers additional sales (H.-S. Chen, Liang, Liao, & Kuo, 2020). FDA refers to a mobile-based application used to connect to various restaurants and food providers, quickly search and order foods for delivery, and pay for the bills without physical interaction with restaurant personnel (Al Amin, Arefin, Alam, Ahammad, & Hoque, 2021). Besides, the app can record the consumers' orders and preferences for the next purchase (H.-S. Chen et al., 2020). FDA is considered a new model for food delivery services in the development of the e-commerce era.

According to Ray, Dhir, Bala, and Kaur (2019), the FDA can be sorted into two distinguished categories. First, the restaurant can provide its own FDA services, such as Domino's, Pizza Hut, KFC, etc. On the other hand, intermediary providers offer a multi-restaurant platform, namely Deliveroo in the UK, Just Eat in the US, Meituan Dianping in China. The worldwide FDA market is forecast to achieve US\$ 62 billion by 2030, increasing at a CAGR of 25% from 2021 to 2030 (alliedmarketresearch.com, 2022). The global FDA has seen the growth of various service providers, led by Delivery Hero, Just Eat, and Uber Eats, in terms of users (Curry, 2022). However, the dramatically rising popularity of FDAs has also fueled the entry of new startups such as Getir, Zapp, and Zepto (Curry, 2022). Due to the fierce competition, the consumer tends to hop between apps to find the best options, which is a significant concern of service providers.

As the FDA's disruptive influence on the market, this domain has attracted scholarly attention regarding the causes of adoption (Belanche, Flavián, & Pérez-Rueda, 2020; C. Hong, Choi, Choi, & Joung, 2021; Ray & Bala, 2021; Ray et al., 2019; Troise, O'Driscoll, Tani, & Prisco, 2020), thereby leaving the concerns of post-adoption stage under-explored. More to this point, by utilizing the theory of Planned Behavior, Al Amin et al. (2021) revealed that delivery hygiene, subjective norms, attitudes, and behavioral control were associated with the intention to continue using FDA. Kumar and Shah (2021) investigated the role of app aesthetics in generating emotions such as pleasure, and arousal, which lead to continued usage intentions for FDA. Y. Zhao and Bacao (2020) suggested that perceived task-technology fit, trust, performance expectancy, social influence, and confirmation have a direct and indirect relationship with users' continuous usage intention of FDA. Francioni, Curina, Hegner, and Cioppi (2022) identified several determinants, including perceived healthiness, quarantine procedures, perceived hygiene, perceived ease of app use, and attitude, that significantly affect continuance intention. Cho, Bonn, and Li (2019) found that four dimensions of perceived value, including convenience, design, trustworthiness, and various food choices, indirectly influence user's intention to continuously use FDA. However, many uncovered perspectives remained confined to investigating the sales mechanism of FDA. For instance, how can a consumer believe a merchant who sells a meal on the platform? Obviously, trust is critical in this process. Hence, this study focuses on the role of trust to understand consumers' reactions toward the information system, which has recently become a main focus in the technology (Shao, Zhang, Brown, & Zhao, 2022).

Although FDA make people's lives more convenient, it receives more complaints from consumers than in other kinds of e-business (Xiao et al., 2019). About 17% of consumers were frustrated because food is not always delivered warm or fresh,

12% were bothered by incorrect orders or restaurants ignoring special instructions, and 9% were irritated by inconsistent or limited menus (Holmes, 2019). Similar to other e-commerce platforms, risk and uncertainty in FDAs are considerably high as the behavior of an e-vendor cannot be guaranteed or monitored (Gefen, Karahanna, & Straub, 2003). However, while several studies have examined the trust formation mechanism to reduce uncertainties within the digital platforms to ultimately drive consumers' behavioral intention, such as social commerce (Kim & Park, 2013; J.-D. Zhao, Huang, & Su, 2019), social media (Liu, Lee, Liu, & Chen, 2018; X. Wang, Wang, Lin, & Abdullat, 2021), B2C e-marketplace (I. B. Hong & Cho, 2011), blockchain-enabled platform (Shao et al., 2022), mobile payment (Cao, Yu, Liu, Gong, & Adeel, 2018), ride-sharing service (Wu & Neill, 2020). Despite great attention having been paid to trust issues in e-commerce, to the best of our knowledge, the nature of the association between FDAs and trust is still limited (Raza, Asif, & Akram, 2022). Thus, there is a need for a better understanding of the primary antecedents that affect consumers' trust in FDA. Besides, consumers who trust the FDA platform may not necessarily trust food providers on the platform and vice versa. In this regard, the study also considers the boundary conditions of trust transfer in the context of the FDA.

Because the sustainable performance of the FDA relies on its continued use by consumers, a more insight into trust factors at this advanced stage of e-commerce development is required. Thus, this study aims to propose the framework to define which trust elements are important to consumers in the FDA and their interrelationship. Additionally, we attempt to identify the determinants of such elements that eventually affect continuance intentions toward FDAs and intention to purchase meals.

This paper is organized as follows: the next section shows the theoretical foundations of the study. The research framework and hypotheses are also presented in this section. The last section explains the chosen method, data collection, and analysis.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Trust and trust transfer

Trust is a complicated concept depicted by scholars in different disciplines, including psychology, economics, and marketing (Doney & Cannon, 1997). X. Chen, Huang, Davison, and Hua (2015) indicated that trust is an essential element in the relationship between the trusting party and the trusted party because of its ability to eliminate risk-related behavior when opportunism and uncertainty emerge. Trust also plays an even more significant role in driving the use of information systems due to the steadily growing complexity of the technology nowadays (Söllner, Hoffmann, & Leimeister, 2016). According to Mayer, Davis, and Schoorman (1995), trust reflects the willingness of one party to be vulnerable to the behaviors of another party. In the e-commerce context, consumers can undergo this vulnerability because they typically lack control over others' activities and are unable to feel, touch, or try out physical products (J. Chen & Dibb, 2010). From e-vendor perspectives, their behaviors on the internet may include unfair pricing, delivering inaccurate information, violations of privacy, unauthorized use of payment information, and so on (Gefen et al., 2003). Gefen et al. (2003) conceptualized trust as a general belief in an e-vendor, such as trustworthiness, integrity, or benevolence, that leads to specific behavioral intentions of consumers through reduced risk. Thus, to facilitate successful transactions in e-commerce, the different stakeholders (e.g., intermediary platform, sellers, consumers) should be involved to produce trust (Xiao et al., 2019).

Trust transfer refers to the process when an individual's trust will be transferred to another target by some other related associations (J.-D. Zhao et al., 2019). According to (Liu et al., 2018), trust transfer can occur through cognitive or communication processes. The trust transfer process involves three parties: the trustor, the trustee, and a third party (X. Chen et al., 2015). In particular, the trustor is a person who assess whether to trust other entity; the trustee is the one whom the trustor judges regarding their trustworthiness; a third party plays a mediating role. In the e-commerce context, three parties, namely intermediary platforms, merchants, and consumers, are involved simultaneously (Xiao et al., 2019). FDA is mobile-based services for ordering food and getting it delivered at specific places. Similar to the online marketplace, various stakeholders, including intermediary platforms, sellers, and users, work together in the FDA. Typically, intermediary platforms take electronic orders from registered users and offer delivery services for their restaurant partners. According to trust transfer theory, if users perceive the source and target as associated, their perception toward the platform can be transferred easily to the sellers. Hence, trust can be enhanced by the trust transfer process within the platform. Therefore, we hypothesize that:

Hypothesis 1: Trust to platform is positively associated with trust to merchant in FDA

The antecedents of trust on platform: Information quality, system quality, and service quality

The study employs DeLone and McLean (1992)'s IS success model to define the critical antecedents to the use of a particular information system. DeLone and McLean (1992) initially suggested six main, distinct dimensions of IS: system quality, information quality, use, user satisfaction, individual impact, and organizational impact. Ten years later, researchers updated the model with six success dimensions: system quality, information quality, service quality, usage, user satisfaction, and net benefits due to the advancement of technology (DeLone & McLean, 2003). Accordingly, system quality is related to the desired features of an electronic system, such as usability, reliability, and response time. Information quality can be defined by the completeness, personalization, and relevance of the web content. Service quality refers to the overall support provided by either the service provider or outsourced. The "intention to use" is an attitude, whereas "use" capture a behavior that measure everything when users visit, navigate, and execute a transaction in a web system. User satisfaction indicates users' opinions of the electronic system. Eventually, net benefits are to measure the integrated impact of e-commerce on various stakeholders. It is explained that three dimensions of quality: information quality, system quality, and service quality will subsequently impact intention to use and user satisfaction in the model (DeLone & McLean, 2003).

Firstly, system quality indicates the general degree of assessment that users evaluate the performance of specific IS in terms of information delivery and its suitability to their requirements (J. V. Chen, Nguyen, & Oncheunjit, 2019). System quality can be measured by ease of use, response time, user interface, reliability and stability (DeLone & McLean, 2003). According to Sharma and Sharma (2019), the absence of these features may drive to the users' negative perceptions toward the IS providers' ability and their integrity to provide quality service. Similarly, in the FDA settings, if users perceive the platform to be trustworthy based on the perceived system quality, then they put trust in the intermediary and are willing to take risks that may result from trusting that FDA platform.

Hypothesis 2: System quality is positively related to trust to FDA platform

Second, information quality reflects the system characteristics, namely completeness, personalization, and relevance of the provided information (DeLone and McLean, 2003). Information quality is one of the essential dimensions of influencing users' attitudes toward technology adoption (Sharma & Sharma, 2019). Jung et al. (2009) argued that information helps establish the users' beliefs, leading to their behavioral intention. Information provided on the FDA includes restaurant information, displayed menus, real-time locations, food information, etc. The FDA that offers relevant, accuracy and timely information to users are likely to gain consumers' trust. Kim and Park (2013) revealed the positive relationship between information and trust in social commerce settings. Thus, we hypothesize that:

Hypothesis 3: Information quality is positively related to trust to FDA platform

Third, the service quality describes the overall level of assessment of the customer support offered by either the service providers or outsourced (DeLone & McLean, 2003). Geebren, Jabbar, and Luo (2021) posit that service quality is evaluated by the reliability, promptness, and professional of the services. According to Zhou (2013), offering high-quality services will signal service providers' ability and benevolence. In an online retail, J. Chen and Dibb (2010) suggested that perceived ability and perceived benevolence are significantly affected by users' support. Therefore, concerns about users' trust in FDA are also driven by service quality provided by the platform. We hypothesize that:

Hypothesis 4: Service quality is positively related to trust to FDA platform

The antecedents of trust on merchant: Perceived product quality, Product presentation richness

There are many arguments among scholars concerning about definition of product quality. Spencer (1994) suggested that product quality refers to the level to which the needs of consumers are satisfied. Researchers distinguish service quality into the objective quality and subjective quality. While objective quality is the actual technical superiority or excellence of the products, subjective quality (or perceived quality) refers to the customers' judgment about the product's overall excellence or superiority (Zeithaml, 1988). Previous studies revealed that consumers establish perceived quality depending on extrinsic cues such as price, brand name, advertisements, and intrinsic cues (Zeithaml, 1988).

Since consumers utilize FDA to purchase foods, they also pay attention to the quality of the foods that can fit their needs (Y.-S. Wang, Tseng, Wang, Shih, & Chan, 2019). There are various quality indicators from the merchant side in the FDA platform, namely providing quality photos, reviews, and ratings that enable customers to select restaurants, food items, and finalize orders (Ray et al., 2019). Past research also indicated that high perceived product quality leads to positive outcomes for consumers. We argue that if the merchants in the FDA offer various indicators to foster its consumers' quality perceptions, then it is likely that consumers will put their trust more in that provider. Thus, we hypothesize that:

Hypothesis 5: Perceived product quality is positively related to trust to merchant in FDA

Product presentation is defined as a specific communication media employed to communicate with potential customers and deliver relevant information to them (Q. Wang, Cui, Huang, & Dai, 2016). The media richness theory posits that media with different degrees of richness influence differently on consumers regarding their communication effectiveness (Daft & Lengel, 1986). Effective information signals may include visible, clear, and credible that help people decrease their information search and processing costs (Dimoka, Hong, & Pavlou, 2012). Consequently, as information increases, uncertainty reduces. In addition, different sorts of product presentations have different information richness. For example, pictures are more informative than text (Q. Wang et al., 2016), and rich graphics and intriguing images attract users' interest (Kumar, Jain, & Hsieh, 2021). In the context of e-commerce, the effectiveness of product presentation formats is also widely examined. Jiang and Benbasat (2007) compare the effect of four types of online product presentation, including static pictures, videos without narration, videos with narration, and virtual product experiences on consumer's product understanding. Dimoka et al. (2012) suggested that effective online product descriptions enhance consumers' awareness of true product quality while reducing product uncertainty. In FDA, besides the restaurant information in the form of text, the owners can provide the images of their places and dishes with proper font size, graphics, color, and other aesthetics to evoke a sense of trust among consumers. Thus, we hypothesize that:

Hypothesis 6: Product presentation richness is positively related to trust to merchant in FDA

The influence of trust on behavioral intention

As discussed earlier, online marketplaces allow consumers to accept the products in the merchants' stores while making transactions and payments through an intermediary platform. As a result, risks and uncertainties are provoked not only from the platform side but also from the merchant providing the products (J. Chen & Dibb, 2010). Therefore, consumers' trust in any form within the platform may be the most critical antecedent of their behavioral intention. Various studies in e-commerce have concluded that consumers who put their trust on the specific targets are likely to show a positive behavioral intentions,

such as intention to purchase (I. B. Hong & Cho, 2011; Kim & Park, 2013; X. Wang et al., 2021) , and repurchase (Xiao et al., 2019; J.-D. Zhao et al., 2019), intention to use the platform (J. Chen & Dibb, 2010; Gefen et al., 2003), and continued usage (Cao et al., 2018; Kumar et al., 2021). In the context of the FDA, when users believe that restaurants provide reliable products as committed, they are more likely to develop the purchase intention and continue using the platform instead of abandoning it. Besides, trust on the platform also plays an essential role in influencing users’ behavioral intention in the FDA. When users form a belief that the platform attempts to reduce opportunistic behaviors, and increase integrity and ability, the high level of trust leads to the positive users behavioral intentions. The above analysis results in the following hypotheses:

Hypothesis 7: Trust to platform is positive related to continuance intention to use the FDA.

Hypothesis 8: Trust to platform is positive related to intention to buy on the FDA.

Hypothesis 9: Trust to merchant is positive related to continuance intention to use the FDA.

Hypothesis 10: Trust to merchant is positive related to intention to buy on the FDA.

Based on the above discussions, we propose the research framework as below:

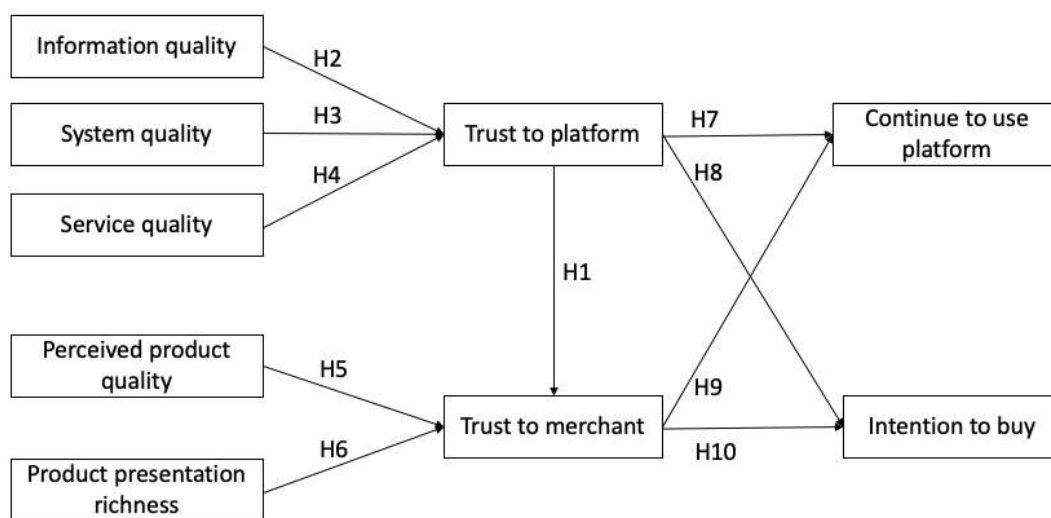


Figure 1: Research framework

RESEARCH METHODOLOGY

Measurement

The measurements of all research constructs are adapted from the literature to suit the research context. We used a seven-point Likert scale, rating from (1) strongly disagree to (7) strongly agree. Besides, demographic variables, namely age, gender, usage frequency, and usage experience were taken into consideration. The detail of measurement is shown in Table 1.

Table 1. The measurement of constructs

Constructs	Items	Sources
Information quality IQ1 IQ2 IQ3 IQ4 IQ5	The information provided by this app is accurate. This app provides me with a complete set of information. The information from this app is always up to date. This app provides me with all the information I need. The information provided by this app is well formatted.	(Lin, 2008)
System quality SYQ1 SYQ2 SYQ3 SYQ4 SYQ5 SYQ6	This app operates reliably. This app allows information to be readily accessible to me. This app responds to my requests timely. This app system is stable. This app system is easy to use. This app provides a friendly user interface.	(Liang, Ho, Li, & Turban, 2011; Lin, 2008; Y. S. Wang, 2008)
Service quality SEQ1 SEQ2 SEQ3	When I have a problem, this app service shows a sincere interest in solving it. This app service is always willing to help me. I feel safe with this app service in terms of security and privacy	(Wang, Wang, & Liu, 2016)

SEQ4 SEQ5 SEQ6	protection. This app service has the knowledge to answer my questions. This app service gives me individual attention. This app service understands my specific needs.	
Perceived product quality PPQ1 PPQ2 PPQ3 PPQ4	I perceive the product offered at this app to be durable. I perceive the product offered at this app to be well crafted. I perceive the product offered at this app to be of high quality. I feel safe to buy the product through this app.	(Teas & Agarwal, 2000; Wells, Valacich, & Hess, 2011)
Product presentation richness PPR1 PPR2 PPR3	The product information is sufficiently detailed. The product presentation richness is visually pleasing. The product presentation richness is well organized.	(Gregg & Walczak, 2008; Mavlanova & Benbunan-Fich, 2010)
Trust to This app TTS1 TTS2 TTS3	The performance of this app always meets my expectations. This app can be counted on as a good site. This app is a reliable site.	(Liang et al., 2011)
Trust to product provider TTPP1 TTPP2 TTPP3	I trust the product provider. I feel that I can trust this product provider completely. I feel secure when I buy product from this merchant because I know that it will never let me down.	(X. Wang et al., 2021)
Continue to use This app CTUS1 CTUS2 CTUS3	I intend to continue using this app rather than discontinue its use. My intentions are to continue using this app than use any alternative means. I prefer to use this app again.	(Bhattacharjee, 2001; Chiu & Wang, 2008)
Intention to buy ITBP1 ITBP2 ITBP3	It is likely that I will buy products from this app. I will purchase the product from this app the next time I need such a product. I will definitely buy products from this app.	(Bennett & Rundle-Thiele, 2002)

Data collection

Data collection was carried out by online questionnaire via Amazon Mechanical Turk (MTurk). The study utilized MTurk’s advanced features to reach the target respondents who are using FDA. A total of 300 responses were obtained for further analysis.

Data analysis

SmartPLS 3.0 was employed in the data analysis process. We carried out various tests to validate the data, including confirmatory factor analysis, reliability, and validity. The research framework was confirmed by examining the significance of path coefficients..

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What drive the successes and adoption of cryptocurrencies?

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ABSTRACT

Since 2008 when Bitcoin was launched, cryptocurrencies (crypto) is increasingly being noticed. Seeing the growth of the crypto-world, different developers have launched their new crypto, possibly motivated by their potential of raising capital or other business opportunities. However, not all crypto can get proliferated. Some cryptos have become valueless gradually after being introduced. To realize the business opportunities brought by launching new cryptos, it is necessary for us to identify the factors that contribute to the success and proliferation of cryptos. In this research-in-progress paper, we presented an ongoing case study based on EOS, a proliferating crypto which has been adopted by different users. We discussed the role and impact of (1) Security, (2) High transaction speed, (3) Low cost and (4) Gamification on how a crypto may be adopted and invested by more users.

Keywords: Cryptocurrencies, EOS, Altcoins, Bitcoin, Initial Coin Offerings.

INTRODUCTION

Cryptocurrency is a digital or virtual currency enabled by cryptography (Li & Whinston, 2020). It has been an emerging concept since Satoshi Nakamoto introduce Bitcoin as a transaction currency (Nakamoto, 2008) and has disrupted the financial world. In 2019, the total market capitalization reached greater than \$130 billion (Roussou, 2019). In addition, the number of cryptocurrencies worldwide has reached over 10000 in February 2022 (Statistia, 2022).

In some countries, the government is considering or has launched its own cryptocurrency. For example, the Central Africa Republic and El Salvador have launched their official cryptocurrency (Chen, 2022), while some other countries have followed in the hope of accelerating transactions and serving the unbanked population (Dierksmeier & Seele, 2018). Moreover, issuing cryptocurrency is a great business opportunity for companies to raise capital. Some firms have launched initial coin offering (ICO) campaigns, which issue cryptocurrency tokens to investors (Preston, 2017).

However, not all of them are successful. For example, LUNA had collapsed in May 2022, which was due to the complication of managing the UST peg across centralized and decentralized trading values. In turn, investors suffered from financial losses of billions (Tan, 2022). Therefore, it will be desirable to explore what drives cryptocurrencies' success and failure. In turn, this would ensure the realization of business opportunities and the benefits of cryptocurrencies. Accordingly, the leading research question (RQ) of this work-in-progress paper is "What factor drives cryptocurrencies' success and proliferations?"

LITERATURE REVIEW

Cryptocurrencies are digital currencies underpinned by cryptographic systems. They enable secure online payments without third-party intermediaries and are generally not issued by any central authority, rendering them theoretically immune to government interference or manipulation. Cryptocurrencies are primarily enabled by blockchain, in which the data cannot be tampered with, destroyed or forged (Di Pierro, 2017).

Cryptocurrencies can be mined or purchased from cryptocurrency exchanges (Krause & Tolaymat, 2018), and has been used for potential financial instruments for trading and cross-border transfers (Mendoza-Tello et al., 2019). However, not all e-commerce sites accept cryptocurrencies for payment. In fact, even for popular cryptocurrencies like Bitcoin, they are hardly used for retail transactions (Carvalho et al., 2020). Table 1 shows a selected list of characteristics of cryptocurrencies, as discussed by previous literature.

Table 1: A Selected List of Characteristics of Cryptocurrencies

Characteristics	Style Rule
Lower transaction fee and convenience	Transactions can be made anytime without limitations with low transaction costs (Moin & Sirer, 2020). Establishing a wallet for cryptocurrencies is even easier than setting up a bank account, which requires documentation and other paperwork (Carvalho et al., 2020).
Fast Transaction	Cryptocurrencies-enabled transactions only take minutes to

Speed	complete, while it may require several days when using wire transfers to accomplish the transaction (Dierksmeier & Seele, 2018). In turn, DNS attacks targeting wire transfer systems may be avoided or handled faster and thus avoid financial losses (DeVries, 2016).
Decentralized	Most, if not all, cryptocurrencies are decentralized and are collectively controlled by their developers and users, who own a significant amount of the cryptocurrencies (Mendoza-Tello et al., 2019). The decentralization helps keep the currency monopoly-free, and no organization alone can determine the flow and value of the coin. In turn, cryptocurrencies will not be controlled by any institutions (e.g., banks) or the government alone (Glaser 2015).
Volatility	The prices of most cryptocurrencies are volatile by nature. On one hand, some users may be discouraged from adopting cryptocurrencies. In some extreme cases, the value may even crash to zero. On the other hand, some users may take such opportunities for speculation, thus earning a profit (Abramova & Böhme, 2016).
Self-Governed	Governance and maintenance of any currency is a major factor in its development. The cryptocurrency transactions are stored by miners on their hard drives (Mukhopadhyay, 2016), and they get the transaction fee as a reward. Since the miners are getting paid for it, they keep transaction records accurate and up to date, keeping the integrity of the cryptocurrency and the records decentralized (Li & Whinston, 2020).

As indicated in Table 1, cryptocurrencies are mostly self-governed, collectively by their developers and owners. While it can be convenient and fast when using cryptocurrencies for transactions, price volatility is expected for cryptocurrencies, given that most are not governed by any central authority and are not officially recognized. In the worst case, it is not only having no financial gain but also total loss is possible (Mita & Tanaka, 2019)

In response to the price volatility issue, some businesses have launched stablecoin, a type of cryptocurrency whose value is pegged to the price of another real-world asset (usually US dollars), with stabilization mechanisms behind to match the price. Stablecoin, in turn, may increase the adoption of cryptocurrencies for transactions, given volatility may otherwise prevent potential investors from acquiring cryptocurrencies (Mita & Tanaka, 2019). Conversely, stablecoin may bring more convenience and transparency compared with the more volatile non-stablecoin. Nevertheless, stablecoins may be considered less profitable due to the lack of speculation opportunities (Moin & Sire, 2020).

Moreover, seeing the opportunities for raising capital or achieving business successes, the introduction of new cryptocurrencies is more commonly seen, in forms of, for example, Initial Coin Offering (ICO). More specifically, ICOs are the activities of issuing digital tokens issued by a blockchain-based platform that allows an issuer to raise capital from multiple investors. The ease of execution, the lack of regulatory oversight and significantly low costs of issuance have attracted many financially constrained issuers to raise capital for their blockchain platform via the ICO market (Preston, 2017). Moreover, Narayanan et al. (2016) argued that three factors related to the proliferation of cryptocurrencies interplay with each other. These factors included blockchain security, ecosystem establishment, and perceived value of cryptocurrencies. For example, upon perceiving a higher security level, investors will trust the cryptocurrency more and are more willing to invest in it. Thus, the value of the cryptocurrency will increase.

However, we identified some limitations from previous literature. For example, for both stable and volatile cryptocurrencies, failure or valueless cases are not uncommon, but they were not adequately discussed. For example, Sharma and Zhu (2020) discussed platform-building in the context of ICO but did not heavily discuss the strategies behind a successful ICO and, thus the subject cryptocurrency of the offering. Narayanan et al. (2016) suggested some possible factors related to the value of cryptocurrencies, but they raised no empirical evidence. While their arguments are reasonable, it will be desirable to have empirical studies to identify the drivers of cryptocurrencies' successes and failures, so that we can realize the advantages and potential of cryptocurrencies.

RESEARCH METHOD

We adopted a case research method with netnography for the following reasons. First, case research methods are robust at exploring 'how' research questions (Benbasat et al., 1987) and processes that cannot be separated from their contexts (Rynes & Gephart Jr, 2004). Second, given the phenomena of cryptocurrencies is multi-dimensional with both external and technological aspects, it has become too complex to adopt an objective research approach (Gable, 1994). A case study approach has, therefore, become appropriate to examine such phenomena (Klein & Myers, 1999).

Netnography is a written account resulting from studying the cultures and communities that emerge from Internet-based communications, where both the fieldwork and the textual interpretation are methodologically informed by the traditions and techniques of cultural anthropology (Kozinets, 2010). It can help discover more profound insights from experiences that are less addressed in earlier research (Langer & Beckman, 2005). All these characteristics are relevant to the phenomena of cryptocurrencies, whose activities are mostly online.

We identified two ideal case selection criteria. First, the selected cryptocurrencies should be highly successful with a significant number of users so that we can build our theories on proven, if not best practices (Pan & Tan, 2011). Second, the developer of the selected cryptocurrencies should have adopted a variety of strategies so that we may identify more theoretical possibilities in response to the phenomenon of cryptocurrencies. Based on the above criteria, we chose EOS as our selected case because of its successes as reflected by its number of users, as well as a wide range of financial products and services developed based on EOS.

We plan to collect data using a mix of data sources such as the EOS official website to cover the voices of a comprehensive range of stakeholders for data triangulation and thus establish a deeper understanding of the phenomenon under study (Venkatesh et al., 2013), to offer richer details to interpret the findings (Gable, 1994) and to ensure the case representativeness (Pan & Tan, 2011). We plan to collect and analyze the data concurrently to take advantage of the flexibility of the case research method (Eisenhardt, 1989). Data from our case study was collected and then coded by using a mix of open, axial, and selective coding processes (Strauss & Corbin, 1998). More indicatively, open coding was used to identify new and validate existing theoretical dimensions. While at the same time, axial coding was used to point out the new, as well as validate existing, second-order themes that could fall under those dimensions (e.g., CSFs of cryptocurrencies successes). The selective coding was then used to distil our case evidence into several first-order categories, which were then assigned to the appropriate dimensions and themes (Pan and Tan 2011). We also plan to utilize visual maps and narratives to summarize our findings (Langley, 1999). The study is still currently ongoing, but this process of iterating between data, analysis, and theory development will continue until the state of theoretical saturation is reached (Eisenhardt, 1989).

CASE DESCRIPTION

EOS was launched in June 2018 by Block.one, with 4.1 billion USD raised. EOS has been a successful volatile cryptocurrency, which is enabled by its exclusive open-source ecosystem (EOS.IO) maintained by Block.one, with long-term profit potential and stable technology behind. The blockchain technology behind EOS.IO can empower many industries and businesses. For example, it can change computer resources and how various applications work. As a result, the value of EOS in the long term can increase (Peters, 2015). Moreover, there is a wide range of applications developed using EOS, with some of them involving the developer of EOS.

PRELIMINARY FINDINGS

Our preliminary findings suggested a few critical success factors that may contribute to the success of cryptocurrencies, including (1) Security, (2) High transaction speed, (3) Low cost and (4) Gamification. Table 2 shows more details about these factors.

Table 2: A Selected List of Characteristics of Cryptocurrencies

Critical Factor	Success	Description
Security		EOS heavily emphasize security protection in their ecosystem. For example, upholding the value of ethical hacking, Block.one has implemented a bug bounty program which rewarded users for reporting security vulnerability issues. These issues may otherwise render EOS-related products or services and lead to disrupted operation and compromised data.
High Transaction Speed		Similar to Ethereum (ETH, another type of cryptocurrency), EOS enables faster transactions and higher scalability. More specifically, the blockchain of EOS can process up to 10000 transactions per second (TPS), far exceeding many other cryptocurrencies, while the blockchain of ETH may only process 15 transactions per second. In addition, it takes only 0.5 seconds on average for a EOS transaction to be confirmed.
Low Cost		While some transaction-associated fees may be required for the operations or services of most cryptocurrencies, this does not apply to EOS.
Gamification		Gamification is deeply embedded in the ecosystem of EOS. For example, Block.one have launched a gamified tutorial called Elemental Battles which teaches developers blockchain essentials and helps them build the first game in the ecosystem. In turn, developers are more engaged and loyal to the ecosystem.

DISCUSSION AND CONCLUDING REMARKS

As follows in our first study, we focused on EOS for studying the critical success factors (CSFs) of cryptocurrencies. While this is an ongoing research project, our current preliminary work has identified some CSFs, including (1) Security, (2) High transaction speed, (3) Low cost and (4) Gamification. These findings echoed with some previous cryptocurrencies literature about their low costs and high transaction speeds (e.g., Li & Whinston, 2020) but we have also identified the role of gamification factors which was discussed in other IS contexts (Lui & Au, 2018), but less commonly discussed in the context of cryptocurrencies.

With future data collection and analysis, we will broaden and validate our findings. The boundary conditions of our implications will also be explained by deeper data analysis and a continuing solid assessment of the literature. We will further develop our theoretical model by gathering and incorporating additional data and then exposing it to in-depth analysis so that a more comprehensive knowledge of cryptocurrencies successes and implications may be developed, not only to give an answer for the research question, but also to create a starting point for the further research of other cryptocurrencies.

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