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Beyond adoption: How co-investment influences 5G user continuance intention: An ECM-VAM multi-group study in China

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A B S T R A C T

This study addresses the critical challenge of low 5G user retention in China, despite extensive infrastructure development. Moving beyond traditional adoption models, we investigate post-adoption continuance intention using a novel integration of the Expectation-Confirmation Model (ECM) and the Value-Based Adoption Model (VAM). Uniquely, we explore the impact of telecom investment strategies—specifically, co-investing vs. independently investing firms—on user perceptions and loyalty. Based on 508 valid responses and multi-group structural equation modeling, we find that while satisfaction and perceived value are key drivers of continuance intention, users' value perception is shaped differently depending on the investment model. This study is among the first to empirically link telecom infrastructure investment models with user continuance intention. The results provide actionable insights for telecommunications operators and governments seeking to improve long-term 5G adoption and retention.

1. Introduction

The swift progression of mobile technology has resulted in the deployment of 5G, a next-generation network that provides markedly higher data rates, much lower latency, and enhanced energy efficiency (Abbosh & Downes, 2019). These technological advancements are expected to enable innovative applications across sectors such as education, healthcare, agriculture, and tourism (Al-Maroof et al., 2021; Cheng et al., 2021). Recognizing this potential, governments worldwide have prioritized 5G infrastructure deployment. China, in particular, has emerged as a global leader, with companies making substantial investments to build an extensive 5G network and expand user access. Despite extensive infrastructure investment, the continued success of 5G depends not only on adoption but also on sustained user engagement. While 5G subscription rates have grown rapidly in China, it remains unclear whether users derive sufficient value from the service to remain loyal over time. Understanding what drives users to continue using 5G after initial adoption is critical for realizing the technology's full potential and ensuring returns on infrastructure investment. To address this challenge, it is critical to investigate the factors influencing user behavior beyond initial adoption—specifically, continuance intention, or the likelihood that users will continue using 5G after subscription (Fishbein and Ajzen, 1975). This is especially important in the mobile context, where users can easily switch providers or revert to 4G if their expectations are not met. Understanding the factors that foster user loyalty is crucial for optimizing the enduring effects of 5G expenditures. The current research aims to address this gap by examining 5G user continuation intention in China, with a particular focus on how infrastructure investment strategies—co-investment versus independent investment—shape user perceptions and behavior. Prior research (e.g., Aimene et al., 2021; Jeanjean, 2022) suggests that co-investment may enhance consumer adoption through improved network quality and cost efficiency. However, the behavioral consequences of such strategies at the user level remain underexplored.

To this end, we adopt an integrated framework combining the Expectation-Confirmation Model (ECM) and the Value-Based Adoption Model (VAM) to evaluate users' post-adoption behavior. ECM emphasizes satisfaction based on the alignment of

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expectations and actual performance, while VAM incorporates both perceived benefits and sacrifices in shaping value perceptions. Together, these models offer an extensive framework to examine how elements like satisfaction, perceived value, system quality, and ease of use affect customer loyalty within a varied telecommunications investment environment.

This study contributes theoretically by integrating two major models in technology adoption literatures and offers practical guidance for telecom operators and policymakers seeking to enhance 5G retention and optimize investment returns.

2. Literature review

Prior research on 5G has primarily concentrated on its technical capabilities and potential applications across sectors such as education, healthcare, and tourism (Al-Maroof et al., 2021; Cheng et al., 2021). While these studies provide valuable insights, they often overlook the behavioral dimension—particularly, how users continue engaging with 5G services after initial adoption. The concept of continuance intention, defined as the likelihood that a user remains subscribed after adoption (Fishbein and Ajzen, 1975), remains underexplored in the current literature.

Shah et al. (2021) and Maeng et al. (2020) represent early attempts to understand user behavior in the context of 5G, but their focus remains largely on initial adoption rather than post-adoption behavior. Given that China commercialized 5G in 2019 and now has a large user base, it is both timely and necessary to examine post-adoption behavior, including satisfaction and user retention.

To explore these dynamics, this study draws on two well-established theoretical frameworks: the Expectation-Confirmation Model (ECM) and the Value-Based Adoption Model (VAM). Bhattacherjee and Lin (2015) applied ECM to analyze continuance intention in information systems, emphasizing how satisfaction, confirmation of expectations, and perceived usefulness shape post-adoption behavior. A key strength of the ECM lies in its ability to evaluate users' post-usage satisfaction by comparing pre-adoption expectations with actual outcomes.

However, the ECM tends to emphasize benefit-driven satisfaction and does not fully capture user-perceived sacrifices, such as price, time, or technical complexity. often neglects sacrifices or costs, such as price or effort. To address this limitation, the present study also incorporates the VAM, which was developed by Kim et al. (2007) and is widely applied in information and telecommunication technology (ICT) research. VAM frames adoption and continuance behavior as a value-maximizing decision, where users assess both perceived benefits (e.g., usefulness, enjoyment) and perceived sacrifices (e.g., price, technical complexity).

Unlike the Technology Acceptance Model (TAM), which primarily considers perceived usefulness and ease of use, VAM captures the economic rationality of users. This makes VAM particularly suitable for services like 5G, where users must weigh high costs against potential functional value (Kuo et al., 2019; Shin, 2009). Prior research has shown that value perceptions significantly influence not only adoption but also retention and switching behavior in mobile services.

Shah et al. (2021) applied VAM to study 5G adoption in China, integrating environmental considerations into the model. However, their study was limited by the sample composition—91% of respondents were still 4G users in 2021. Consequently, their study did not capture actual post-adoption experiences, and the ECM was not applied. To fill this gap, the current study focuses on actual 5G users and consolidates ECM and VAM into a cohesive framework to examine the factors influencing continuation intention within telecom investment strategies.

3. Theoretical model and hypothesis

3.1 Value-based adoption model (VAM)

VAM was developed by Kim et al. (2007) as an extension of the Technology Acceptance Model (TAM), originally introduced by Davis (1989). Kim et al. (2007) argue that the TAM has constraints in understanding the adoption of new ICT, underscoring the need to perceive new ICT users not solely as technology users but also as service consumers.

The VAM and TAM employ different methodologies. The perceived value and consequent desire to utilize the VAM are predominantly shaped by its advantages (usefulness and enjoyment) and sacrifices (technical complexity and perceived costs). In contrast, the TAM primarily focuses on elucidating the rationale for technology adoption by evaluating its perceived usefulness and user-friendliness. Furthermore, the VAM utilizes a cost-benefit analysis that encapsulates the decision-making process wherein individuals evaluate the costs and uncertainties associated with the adoption of a new technology or product (Lin et al., 2012). The VAM seeks to elucidate the technology adoption process by integrating the TAM and accounting for customers' perceived value. The objective of this integration was to surmount the limitations of the TAM within the context of expanding ICT environments.

3.1.1 Perceived benefits

Perceived benefits, defined as the advantages offered by technology, products, or services, constitute a crucial aspect of user perceptions (Shin, 2009). Kim et al.'s (2007) framework categorizes these benefits into two primary factors: perceived usefulness and enjoyment. Recent studies in the technology adoption literature emphasize the significance of higher speed, network reliability, availability, accessibility, enhanced quality, and entertainment value as highly desirable benefits (Russell, 2018; Shah et al., 2021).

The concept of perceived usefulness is paramount in the VAM. Perceived usefulness describes how seriously people take the idea that a product or service might boost productivity and efficiency in their work. This study elucidates the perceived usefulness of the 5G network as the degree to which users subjectively assess its potential to augment their work productivity and efficiency, while concurrently providing convenience in their daily activities. We adopt this idea as a direct factor that influences both users' perceived pleasure and their intention to continue using information systems and services (Park and del Pobil, 2013).

5G serves purposes beyond improving business operations and facilitating job tasks; it also offers a wide range of entertainment options such as online gaming, social networking, and high-quality online music and films for customers (Shah et al., 2021). Enjoyment and amusement have a favorable impact on an individual's inclination to apply a particular technology (Al-Maroof et al., 2021). Compared to its predecessor, 4G technology, 5G represents a significant leap forward, providing high-quality content through rapid transmission, thereby enhancing the overall consumer viewing experience. Therefore, within the 5G framework, we propose the following hypothesis:

H1: *Perceived benefit has a positive influence on perceived value in the context of 5G.*

3.1.2 Perceived sacrifice

Perceived sacrifice refers to the combined impact of tangible expenses and the cognitive exertion involved in using a certain product or service (Shah et al., 2021). Prior studies emphasize the significance of consumer expenses and exertion when assessing items or services (Kim et al., 2007; Roostika, 2012). These sacrifices may appear in both financial and nonfinancial forms (Kim et al., 2007). Monetary costs refer to the specific price of goods, whereas non-monetary costs comprise the time, effort, and other negative aspects experienced during the purchase and consumption of the product. Technical issues and price are major obstacles to the adoption of mobile internet (Kim et al., 2007). The following discussion explores perceived sacrifices, primarily focusing on technical elements (non-monetary sacrifices) and perceived fees (monetary sacrifices).

Technicality, in definition, pertains to the level at which the mobile Internet is technically superior in providing services. Users assess the technicality by evaluating their subjective judgments of usability, connectedness, and effectiveness. Usability pertains to the absence of physical, cognitive, and educational exertion on the system, whereas connectedness emphasizes the promptness and simplicity of connections. Efficiency considers variables, such as loading and response times, which can be perceived as time expenses. The overall technical complexity of a system is a combination of various intangible expenses. In the VAM framework, technicality explicitly refers to the level of simplicity with which a technology can be used. Perceived ease of use refers to the subjective perception of consumers regarding their capacity to effectively use technology, namely mobile devices (Akour, 2010). This perception is strongly linked to the concept of technology, which requires less effort and affects user motivation. Users' perceptions of their proficiency in applying a service or technology positively influence their inclination to actively participate, thus promoting enhanced interaction (Odiakaosa and Jere, 2017). Mutono and Dagada's (2016) study on learners' preparedness for specific technologies demonstrates that when technology is seen as easy to use, users experience reduced levels of anxiety and irritation. The idea that technology is both beneficial and user-friendly has a substantial impact on people's inclinations to utilize it. Perceptions of the simplicity of using technology significantly influence people's inclinations to embrace and interact with technology. Consequently, people's inclination to utilize technology is significantly influenced by their attitudes toward simplicity. Therefore, we propose the following hypothesis.

H2: *There is a positive relationship between ease of use and the perceived value of 5G.*

The perceived fee is a cognitive representation of the real cost of an item or service. Within the domain of 5G mobile Internet, clients compare the present pricing with previously existing costs linked to the 4G network. This comparison provides vital insights into customer perceptions of fees and serves as a crucial indicator for pricing assessment. Perceived fees or costs refer to the evaluation of a service's advantages in proportion to its price or cost (Kim et al., 2007). If people believe that the cost of a service is greater than its advantages, they may choose not to subscribe. Cost and price are significant factors determining the extent to which potential consumers adopt a technology (Cheng et al., 2021; Kim et al., 2007). We propose the following hypothesis.

H3: *Perceived fee has a negative influence on the perceived value of 5G.*

3.1.3 Perceived value

Kuo et al. (2009) assert that perceived value equates to consumer surplus. This is ascertained by subtracting the actual payment made by customers for items from the maximum price they are willing to pay. Kim et al. (2007) assert that perceived value arises from a balanced interplay between perceived benefits and sacrifices. In this study, the phrase "perceived value of 5G" denotes an individual's thorough assessment of 5G services, which is derived from a meticulous consideration of its benefits and drawbacks.

Previous studies in conventional retail environments have consistently shown a positive correlation between perceived value and customer satisfaction (Kuo et al., 2009), emphasizing a robust relationship between the two dimensions. Based on this evidence, we suggest the following hypothesis.

H4: *Perceived value in 5G services has a positive impact on user satisfaction.*

3.2 Expectation-confirmation model (ECM)

The ECM is a prominent theory in the fields of information systems and technology (Park, 2020). Expectation-confirmation theory serves as the underlying framework for the ECM first proposed by Oliver (1980). This model investigates the correlation between user intention to repurchase, contentment, perceived performance, and expectations. The ECM is frequently used to clarify persistent utilization of ICT products and services. It offers valuable observations of people's behavior once they embrace a specific technology. Oghuma et al. (2016) state that the ECM is constructed based on three fundamental principles. ECMs largely emphasize post-acceptance elements given that the confirmation and satisfaction constructs are already account for the effects of pre-acceptance variables. Furthermore, because of the dynamic nature of information systems (IS), the ECM assesses expectations after consumption (ex-post) rather than before consumption (ex-ante). The model indicates that post-purchase expectations are represented by perceived usefulness after a purchase.

The ECM posits that satisfaction arises from the amalgamation of expectations and apparent performance, which may have either a positive or negative relationship between them (Baharum and Jaafar, 2015). A product that surpasses expectations results in positive confirmation, which ultimately leads to contentment. When a product does not match expectations, consumers are likely to feel dissatisfied (Oliver, 1980). This framework comprises four main components: expectations, performance, confirmation, and satisfaction. Expectations are a manifestation of expected conduct and can forecast the future attributes of a product (Bhattacherjee, 2001)

Bem (1972) introduced self-perception theory, which asserts that individuals adjust their expectations based on their understanding of their own conduct and that of others. Some researchers apply this theory to explain the creation and application of the ECM by users (Bhattacherjee, 2001). Consequently, user expectations regarding information technology or services are updated in light of fresh information and personal experiences. This ultimately illustrates the degree to which consumer behavior changes after they accept items or services (Thong et al., 2006).

3.2.1 Satisfaction

Users' perceived satisfaction refers to the emotions and impressions that arise after they buy and use a product or service (Bhattacherjee and Premkumar, 2004). This study focuses on users' comprehensive experiences, including the process of obtaining and using 5G technology. Hsiao and Chen (2018) states that users' desire to continue using a specific information system or service is positively impacted by their overall happiness with its utilization, as per the ECM. The correlation between perceived happiness and intention to use has been consistently examined in the context of novel technologies and related products (Park, 2020). For instance, Baharum and Jaafar (2015) discovered that the happiness of users of websites specifically designed for multicultural applicants had a substantial impact on their intention to use them. Therefore, we propose the following hypothesis.

H_5: *Satisfaction positively correlates with the desire to continue using 5G.*

3.2.2 Confirmation

As defined in the ECM, confirmation pertains to the extent of agreement between users' expected performance and actual outcomes regarding the use of information systems and services (Hsu and Lin, 2015). This component significantly affects consumers' perceived satisfaction with information systems and services. Previous research identifies consumers' perceived satisfaction as a pivotal factor influencing their intention to continue using particular information systems or services (Park, 2020). Perceived satisfaction relates to consumers' evaluation of their whole experience with a particular system or service (Bhattacherjee, 2001). Hence, subsequent sections delve into the roles and purposes of pleasure and confirmation.

The ECM asserts that user satisfaction and opinions regarding technology and services are essential factors influencing the intention to continue their use. The level of confirmation of real usage substantially influences continuance intention (Hsu and Lin, 2015). The principle of user confirmation is widely acknowledged and accepted in the domain of new technologies. This statement reflects individuals' subjective viewpoints regarding the anticipated benefits, which exert a substantial influence on their overall contentment (Ha et al., 2017). Consequently, when users experience anticipated advantages, their contentment and subsequent inclination to persist in using the system or service are greatly amplified. Therefore, the same patterns may be observed among users of 5G networks and we propose the following hypothesis.

H_6: There is a positive relationship between confirmation and user satisfaction in the context of 5G.

3.2.3 Service and system quality

Following Park (2020), we did not employ expectations in our preliminary assessment. Instead, we utilize service and system quality as metrics to evaluate relevant attributes and measure consumer perceptions prior to subscribing to 5G. Our main objective is to evaluate the quality of services and systems to measure consumers' attitudes before implementing 5G technology. The notion of perceived system quality is typically characterized as "the degree to which users perceive a system's performance during usage" (Park, 2020). With advancements in information systems and services, users now consider service quality when evaluating perceived system quality. This transition arises since most of the users do not have direct interaction with system components and capabilities. Therefore, their comprehension of system functionality encompassed both the system's quality and the service rendered. Several studies assess the influence of users' perception of system and service quality on their confirmation and overall satisfaction with innovative and revolutionary information technologies (Oghuma et al., 2016). Users who consider an information system as providing exceptional service quality are more inclined to exhibit elevated levels of satisfaction and affirm their intention to continuously use the system (Chen and Chang, 2018). These findings indicate that when consumers recognize an elevated quality in the systems and services of the 5G networks, they experience an increased degree of happiness and confirmation of their use.

In our study's context, perceived system quality refers to "the degree to which users perceive a system's performance during usage." With advancements in information systems and services, users now consider service quality when evaluating perceived system quality. As users rarely interact with the system infrastructure directly, they assess quality based on both technical aspects and service delivery. To reflect the specific functionalities of 5G, we adopt a multidimensional approach. This encompasses network speed, which measured by download and upload speeds experienced by users. Network coverage refers to the geographical area in which 5G services are available. We consider user perceptions of the adequacy of 5G coverage in these areas. The customer service dimension focuses on the responsiveness, helpfulness, and expertise of the service provider in addressing user inquiries and resolving issues related to 5G technology. By incorporating these 5G-specific aspects into our measurement of service and system quality, Our objective is to attain a more thorough comprehension of how these elements affect consumer satisfaction, confirmation, and, eventually, the desire to continue using 5G services. Therefore, we put forth the subsequent hypothesis.

H$_7$: *The quality of service and system performance are positively associated with perceived satisfaction with 5G.*

3.2.4 Continuance intention

Continuation intention refers to consumers' inclinations to repeatedly choose a particular store to purchase goods or services and share their usage experiences with friends and family (Kuo et al., 2009). Zeithaml et al. (1996) employ loyalty, switching behavior, willingness to pay more, and external and internal responses as metrics to evaluate post-purchase intention. Cheng et al. (2021) use repurchase intention and word-of-mouth (WoM) to assess consumer continuity. Repurchase intention involves individuals consistently buying products or services from the same company, which is primarily driven by positive past purchasing experiences (Kuo et al., 2009). Retaining existing customers often requires lower marketing expenditures than acquiring new customers (Zeithaml et al., 1996).

Numerous studies establish a clear correlation between perceived value and repurchase intention. The perceived value of a product or service significantly influences a customer's likelihood of repurchase (Cheng et al., 2021; Kuo et al., 2009). Cronin et al. (2000) conducted a cross-industry study demonstrating that the perception of value positively affects the desire to persist. Wang et al. (2004) demonstrate that the perception of value positively affects the inclination to engage in future purchases. Lin and Wang (2006) identify a clear association between perceived value and consumer loyalty. Consequently, we put up the subsequent hypothesis.

H$_8$: *The perceived value positively affects the intention to continue using 5G.*

Based on this discussion of the literature and hypotheses, we establish the research model in Fig. 1.

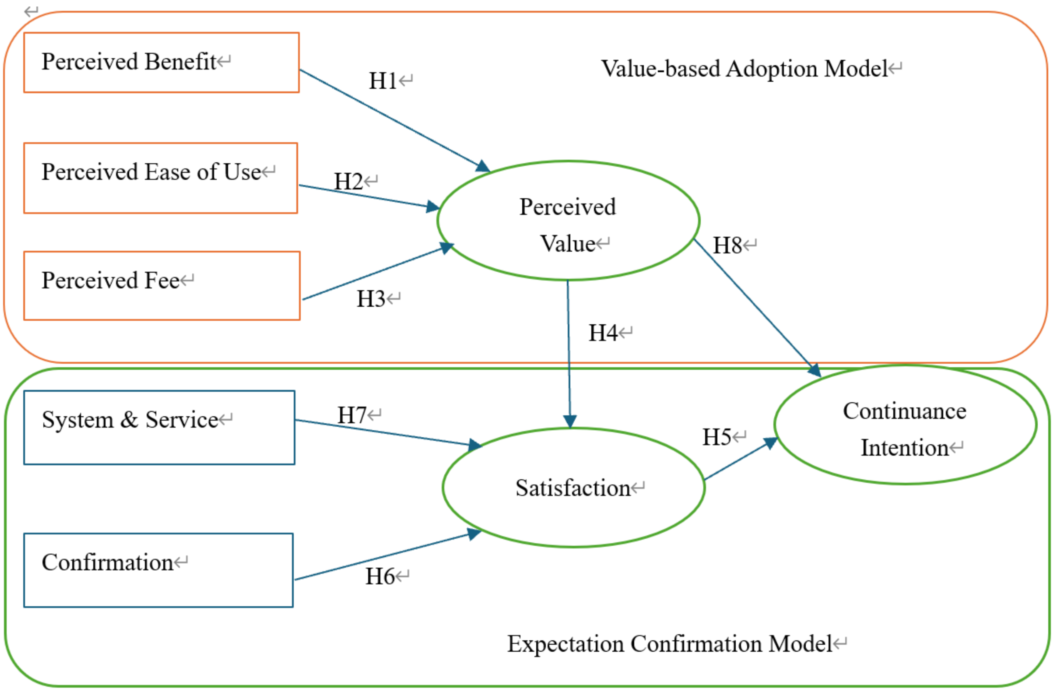

Fig. 1. Research Model

4. Methodology

Our study utilizes partial least squares structural equation modeling (PLS-SEM) to assess the suggested model and determine the elements affecting customers' desire to continue using 5G. PLS-SEM is particularly appropriate for the objectives of this investigation for two primary reasons. Initially, we employed a confirmatory methodology. We sought to evaluate and confirm the proposed links inside the model. Covariance-based SEM (CB-SEM) approaches, often utilized in software like AMOS, focus on validating established theories, whereas PLS-SEM is adept at this confirmatory methodology (Hair et al., 2017). PLS-SEM aims to optimize the variance elucidated in the dependent variable (continuance intention) by the independent factors inside the model. This focus on predictive capability clearly corresponds with our research objective of identifying the aspects that most substantially affect consumers' decisions to persist in utilizing 5G technology.

Second, the characteristics of our research model further bolster the suitability of the PLS-SEM. Our model likely incorporates reflective constructs, in which latent variables are reflected by their observed indicators. PLS-SEM is particularly adept at handling these reflective constructs. Additionally, the exploratory nature of some aspects of our research, in which we might seek to refine the existing theory based on the data, aligns well with the flexibility of PLS-SEM. While confirmatory analysis is the primary focus, PLS-SEM can accommodate exploratory elements within the model.

Finally, the nature of our data informed the selection of PLS-SEM, as it does not require multivariate normality assumptions.

4.1 Questionnaire design

This study followed standard procedures for questionnaire development. At first, a total of 27 measurement items were adapted from previous studies on user behavior in technology adoption (Kim et al., 2007; Baharum & Jaafar, 2015; Park, 2020; Shah et al., 2021; Kuo et al., 2009; Cheng et al., 2021; Haq et al., 2023). The constructs measured in this study included perceived benefit, perceived ease of use of 5G technology, perceived value for price, service quality, system quality, confirmation, satisfaction, and continuance intention. Each construct was assessed using a five-point Likert scale, where 1 = strongly disagree and 5 = strongly agree.

The initial questionnaire was designed in English and translated into Chinese by two professional translators. To ensure the accuracy, relevance, and alignment of the questionnaire items with the study's objectives, three professors specializing in consumer behavior reviewed and revised the translated items. Their feedback ensured that the items were appropriate for the research context and effectively captured the constructs of interest.

Subsequent to these modifications, a pilot survey was executed with 73 5G users in China to evaluate the reliability and validity of our questionnaire items. Two items that failed to achieve the tests were eliminated based on the pilot survey findings. The concluding questionnaire had 25 items, as detailed in Table 1.

Table 1
Questionnaire items

Constructs	Items
Perceived Benefits (Kim et al., 2007; Shah et al., 2021)	PB1: 5G is very helpful in my daily life. PB2: 5G makes it easier for me to accomplish tasks. PB3: 5G provides me with more entertainment. PB4: 5G services are more useful compared to that of 4G.
Perceived Ease of Use (Baharum and Jaafar, 2015; Kim et al., 2007; Park, 2020)	PE1: 5G is easy to use. PE2: Transitioning from 4G to 5G is easy for me to adapt. PE3: Using 5G consumes a lot of energy.
Perceived Fee (Park, 2020; Shah et al., 2021)	PF1: The cost for using 5G is expensive. PF2: The services that 5G provides are time consuming. PF3: Using 5G cause me a burden.
Perceived Value (Shah et al., 2021)	PV1: In relation to the spending of both time and money required, the utilization of 5G provides substantial value. PV2: Considering both the advantages and disadvantages, I find the use of 5G beneficial. PV3: I perceive strong value in using 5G.
Service and System Quality (Cheng et al.,2021; Haq et al., 2023)	SS1: The current telecom operator provides me with good customer service. SS2: The current telecom operator has a wider 5G network coverage. SS3: The quality of the 5G network I am currently using is high (e.g. stable in video call, upload and download speed)
Confirmation (Park, 2020)	CN1: My experience with 5G has exceeded my expectations. CN2: In general, my expectations for 5G have largely been fulfilled. CN3: 5G has demonstrated greater functionality than I initially anticipated.
Satisfaction (Park, 2020)	ST1: On the whole, I am satisfied with the performance of 5G. ST2: 5G meets my former expectations. ST3: Using 5G gives me a great sense of satisfaction.
Continuance intention (Baharum and Jaafar, 2015; Kuo et al., 2009; Park, 2020)	CI1: I will continue using 5G after I use it. CI2: I will continue using my current 5G network without switching to other operators. CI3: I intend to recommend my current telecom operator's 5G service to friends and family.

4.2 Sampling method

4.2.1 Research participants and sampling strategy

To ensure the validity and generalizability of our findings, we implemented a systematic approach to participant selection.

The target population for this study consisted of individuals in China who are 18 years or older and actively use 5G network services. Given the vast size and geographic dispersion of this population, it was not feasible to employ a probability-based random sampling strategy. Therefore, following Shah et al. (2021), we adopted a snowball sampling method.

Initial respondents were recruited through the researchers' personal networks and were subsequently encouraged to share the questionnaire with others in their networks. This approach facilitated the rapid dissemination of the survey to a broad pool of participants across China.

While snowball sampling offers practical advantages for accessing a large and geographically dispersed population within a limited timeframe, it inherently carries the risk of selection bias, as participants are more likely to refer others with similar characteristics. To mitigate this potential bias, we made deliberate efforts to ensure broad geographic coverage and diversity in the sample. Specifically, the questionnaire was distributed widely, and respondents were encouraged to share it with contacts across different provinces and demographic groups. As a result, the final dataset includes responses from participants in 30 out of 31 provincial-level divisions in mainland China.

4.2.2 Sample size determination

We determined our sample size based on methodological suitability, model complexity, and precedent in prior PLS-SEM studies. Given that our structural model includes eight latent constructs with multiple indicators and interrelationships, a sufficiently large sample was needed to ensure reliable estimation and statistical power. We adopted PLS-SEM as our analysis technique, which is well-suited for exploratory models and does not require the large sample sizes typically demanded by covariance-based SEM. Previous studies using similar approaches have demonstrated robust results with samples ranging from 300 to 500 participants (e.g., Shah et al., 2021). Accordingly, we targeted a sample size of 500 to 600 respondents, balancing analytical rigor with feasibility, and ensuring the robustness of our results.

4.3 Multi-group analysis

Following data collection from the online survey platform, we employed SEM to analyze the research model. To attain a more profound comprehension of the hypothesized relationships within the model, we utilized multi-group analysis (MGA). MGA is a robust statistical technique embedded within SEM that allows researchers to compare model parameters (e.g., path coefficients) across predefined groups. The primary aim of the MGA is to assess measurement and structural invariances between groups. Measurement invariance ensures that the research instrument measures the same constructs in the same manner for each group. Conversely, structural invariance assesses whether the hypothesized relationships between constructs hold across different groups.

Conducting a MGA offers several methodological and theoretical advantages to our research. First, establishing measurement and structural invariance across user groups (co-investing vs. independently investing firms) enhances the generalizability of our findings. Second, even in cases where full invariance is not achieved, MGA enables the identification of specific path coefficients that differ between groups-providing valuable insights into how investment strategies may moderate user perceptions and behaviors. Finally, the findings from MGA can guide theoretical refinement by revealing potential moderating effects and group-specific boundary conditions within the proposed model.

In this study, we leverage MGA to specifically examine whether the influence of co-investment in 5G infrastructure on users' continuance intention differs between the two groups (users interacting with co-investing firms vs. those interacting with independent firms). This comparison can yield a more nuanced understanding of how investment models influence user behavior.

4.4 Data collection

We conducted an online survey specifically targeting individuals in China who actively use the 5G mobile network, in order to collect data for this research. The survey was hosted on the reputable platform Survey.work (https://survey.work.com). A snowball sampling method was employed: the questionnaire was initially distributed among the researchers' personal networks, who were then encouraged to forward it to their own contacts. This strategy was adopted to help reach a geographically diverse respondent base despite the limitations of non-probability sampling.

Participant privacy and data confidentiality were strictly upheld. A clear notice accompanied the survey, informing participants that all responses would remain anonymous and would be used exclusively for academic purposes. This study received ethical approval from the Universiti Malaya Research Ethics Committee (UMREC).

The survey had two separate sections: the initial piece gathered demographic data, while the latter section concentrated on critical factors pertinent to our study model (the whole questionnaire is included in the Appendix). A total of 574 replies were obtained. A comprehensive screening procedure was conducted to guarantee the integrity and trustworthiness of the data. Responses that were incomplete or inconsistent were eliminated, yielding a final dataset of 508 valid questionnaires suitable for rigorous statistical analysis. Table 2 outlines the demographic attributes of the survey participants.

Table 2
Demographic characteristics of the respondents (N=508)

Age	Frequency	Percentage	Living areas	Frequency	Percentage
18-25	189	37.20%	Metropolis	157	30.90%
26-35	226	44.49%	Medium sized cities	206	40.55%
36-45	54	10.63%	Smal cities and rural areas	145	28.55%
Over 46	39	7.68%			
Gender			5G network users		
Male	291	57.30%	China Mobile	304	59.84%
Female	217	42.70%	China Telecom	118	23.23%
			China Unicom	86	16.93%

5. Results

5.1 Descriptive analysis

Table A1 (see Appendix) shows the descriptive statistics for the central trends (averages) and dispersion (variations) of the scores for each construct in our study model. This table offers a fundamental summary of user attitudes and experiences about 5G technology, based on the components examined in this study.

5.2 Reliability and validity tests

Similar to previous studies (Alegre & Chiva, 2013; Ifinedo, 2011), common method bias (CMB) is a potential concern in our research design because of the use of self-reported surveys. This bias can arise when participants' responses across the survey are influenced by a common source, such as the survey format. To assess the potential influence of CMB, we followed James et al. (2013) approach for PLS models and examined the Variance Inflation Factors (VIF) to identify potential multicollinearity among the variables. Multicollinearity can be indicative of CMB as it suggests inflated relationships between variables. Our analysis revealed that all VIF values were less than 5 in the inner model (Table A2 in Appendix), suggesting a low risk of CMB based on multicollinearity according to the criteria established by James et al. (2013).

Table 3
Internal and convergent reliability

Factor	Items	Cronbach's alpha	Factor loadings	Composite reliability	Average variance extracted
Continuance Intention	CI1	0.899	0.91	0.937	0.832
	CI2		0.893		
	CI3		0.932		
Confirmation	CN1	0.944	0.946	0.964	0.9
	CN2		0.946		
	CN3		0.954		
Perceived Benefits	PB1	0.925	0.884	0.947	0.816
	PB2		0.93		
	PB3		0.883		
	PB4		0.915		
Perceived Ease of Use	PE1	0.849	0.893	0.908	0.768
	PE2		0.869		
	PE3		0.866		
Perceived Fee	PF1	0.788	0.639	0.855	0.668
	PF2		0.864		
	PF3		0.921		
Perceived Value	PV1	0.904	0.92	0.94	0.839
	PV2		0.93		
	PV3		0.921		
Service & System Quality	SS1	0.848	0.892	0.908	0.767
	SS2		0.845		
	SS3		0.889		
Satisfaction	ST1	0.904	0.923	0.94	0.839
	ST2		0.894		
	ST3		0.931		

We evaluated the internal consistency of each design with Cronbach's alpha. All constructs surpassed a score of 0.7, demonstrating a substantial level of reliability in the questionnaire. Convergent validity was confirmed by the analysis of factor loadings, with all items exhibiting significant loadings above the suggested criterion of 0.5 (Wang et al., 2022; Cheung et al., 2024). The findings demonstrate that the questionnaire questions successfully converged and encapsulated the targeted constructs. The discriminant validity was ultimately confirmed by comparing the square root of the average variance extracted (AVE) for each construct against its strongest association with other components. The data in Tables 3 and 4 indicate that the square root of the AVE for each construct exceeded its maximum correlation value, hence confirming the distinctiveness of the constructs. Moreover, all AVE values surpass the generally advised criterion of 0.5, so reinforcing the constructs' capacity to elucidate a minimum of fifty percent of the variation in their corresponding indicators. The successful evaluation through reliability and validity tests offers compelling evidence that the questionnaire accurately evaluated the targeted components, resulting in reliable and valid data for subsequent analysis within our research paradigm.

To assess discriminant validity, we applied the Fornell-Larcker criterion (Fornell and Larcker, 1981). As shown in Table 3, the square root of each construct's AVE (on the diagonal) is greater than its correlations with all other constructs (off-diagonal). This indicates that each construct shares more variance with its own indicators than with any other construct, thereby confirming discriminant validity.

Table 4
Fornell-Larcker Discriminant validity

Factor	1	2	3	4	5	6	7	8
1.Continuance Intention	0.912							
2.Confirmation	0.798	0.949						
3.Perceived Benefits	0.761	0.747	0.903					
4.Perceived Ease of Use	0.727	0.664	0.701	0.876				
5.Perceived Fee	0.224	0.257	0.295	0.281	0.817			
6.Perceived Value	0.803	0.772	0.836	0.815	0.296	0.916		
7.Service &System Quality	0.776	0.809	0.794	0.693	0.282	0.833	0.876	
8.Satisfaction	0.87	0.884	0.81	0.741	0.271	0.846	0.844	0.916

5.3 Model fit evaluation

For the PLS-SEM analysis, we utilized SmartPLS 4 software. Our PLS-SEM analysis yielded satisfactory fit indices, demonstrating the model's ability to represent data and predict consumers' 5G continuance intentions. A crucial indicator in PLS-SEM is the R^2, which emphasizes predictive power. The R^2 values for the endogenous variables in this study varied between 0.772 to 0.855. The elevated values signify that the model accounts for a considerable share of the variance in these variables, accurately forecasting the determinants affecting customers' continued intention to utilize 5G service offered by current telecom operators.

The standardized root mean squared residual (SRMR) quantifies the average difference between the observed and predicted correlations in the model. Reduced SRMR values signified an improved fit. The SRMR value for the calculated model was 0.055, which is below the required threshold of 0.08. This outcome indicates a strong alignment between the actual and anticipated relationships in the model.

The combined effects of these fit indicators illustrate the model's effectiveness in capturing the relationships between variables and accurately predicting the determinants that influence consumers' inclinations to persist in using 5G service.

5.4 Hypothesis tests

5.4.1 Complete research model

Table 5 and Fig. 2 summarize the results for the unconstrained research model, which examines the overall relationships without considering a specific investment firm (co-investing or independent). The analysis highlights that both user satisfaction (H5) and the perceived value toward 5G (H8) positively affect their continuance intention to use the service (R^2=0.772). This result suggests that ensuring customer satisfaction and user perceptions of value in 5G services is crucial for driving user retention.

Table 5
Unconstrained research model results

Hypothesis	Sample mean	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
H1. Benefit→ Perceived Value	0.516	0.059	8.751	0.000
H2. Ease of Use→ Perceived Value	0.448	0.062	7.168	0.000
H3. Perceived Fee→Perceived Value	0.019	0.02	0.889	0.187
H4. Perceived Value→Satisfaction	0.307	0.055	5.608	0.000
H5. Satisfaction→Continuance Intention	0.673	0.057	11.826	0.000
H6. Confirmation→Satisfaction	0.497	0.052	9.525	0.000
H7. System &Service→Satisfaction	0.186	0.044	4.226	0.000
H8. Value→Continuance Intention	0.235	0.06	3.879	0.000

Technology adoption factors such as perceived benefits (H1) and ease of use (H2) positively influenced users' perceived value toward 5G (R^2=0.801). Hence, users place value on functionality and user friendliness when evaluating 5G services. Interestingly, perceived fees (H3) do not exert a statistically significant influence on perceived value, indicating that other factors have a more substantial impact on molding perceived value inside the unconstrained model.

The post-purchase evaluation factors system and service quality (H7) and confirmation (H6) are both positively related to satisfaction (R^2=0.855). This outcome suggests that consumers who recognize high system and service quality in the existing 5G network and believe their expectations are fulfilled are more inclined to be satisfied with the service. The perceived value created by 5G (H4) positively influences consumer satisfaction, akin to previous models.

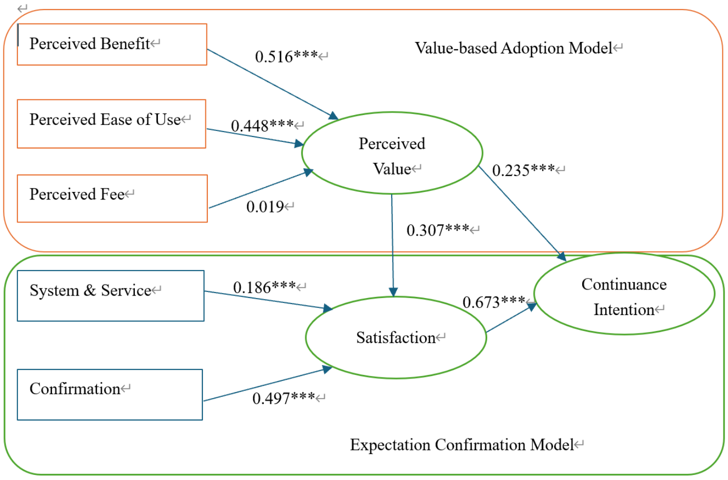

Fig. 2. Summary of the complete model results (***p<0.001; **p<0.05).

5.4.2 Research model for co-investing firms

Table 6 and Fig. 3 summarize the results of the research model for co-investing firms. Similar to the complete model, both user satisfaction (H5) and their perceived value of 5G (H8) positively affect their continuance intention. Hence, for co-investing firms, ensuring customer satisfaction and users' perceptions of value in 5G services is crucial for driving user retention.

Factors influencing technology adoption, including perceived advantages (H1) and ease of use (H2), positively affect consumers' perceived value of co-investing enterprises. These results correspond with the findings of the comprehensive model, indicating that these elements are significant in both investment models. Interestingly, perceived fees (H3) again have no statistically significant effect on the perceived value of co-investing firms, confirming the outcome of the complete model.

The post-purchase evaluation factors system, service quality (H7), and confirmation (H6) are all positively related to the satisfaction of co-investing firms. Consequently, consumers who recognize high system and service quality and believe their expectations are fulfilled are more inclined to be satisfied with the current service. The perceived value generated by 5G services (H4) positively affects consumer satisfaction with co-investing firms.

Table 6
Research model results for co-investing firms

Hypothesis	Sample mean	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
H1. Benefit→ Perceived Value	0.394	0.079	4.892	0.000
H2. Ease of Use→ Perceived Value	0.546	0.085	6.571	0.000
H3. Perceived Fee→Perceived Value	0.045	0.084	0.941	0.174
H4. Perceived Value→Satisfaction	0.245	0.069	3.669	0.000
H5. Satisfaction→Continuance Intention	0.622	0.052	11.863	0.000
H6. Confirmation→Satisfaction	0.518	0.078	6.554	0.000
H7. System &Service→Satisfaction	0.237	0.067	3.514	0.000
H8. Value→Continuance Intention	0.281	0.059	4.744	0.000

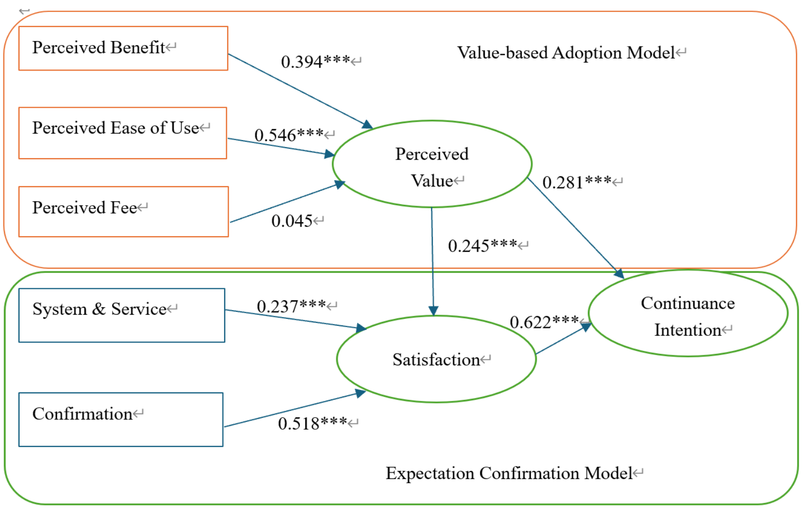

Fig. 3. Results summary for co-investing firms (***p<0.001; **p<0.05)

5.4.3 Research model for independently investing firm

Fig. 4 and Table 7 summarize the results of the research model for an independent investing firm. Unlike the complete and co-investing models, service and system (H7) do not impose a statistically significant impact on consumers' perceived value derived from utilizing 5G. This result suggests that, for independently investing firms, factors beyond perceived value might play a stronger role in user decisions to continue using the service. However, user satisfaction (H5) has a strong positive relationship with continuance intentions. Users exhibiting higher satisfaction with a service are more inclined to retain their affiliation with an independent investment business.

Technology adoption factors, such as perceived benefits (H1) and ease of use (H2), positively influence users' perceived value of independent firms. Thus, independent firms should prioritize these aspects when designing and marketing 5G services. Similar to the complete and co-investment models, the perceived fee (H3) has no significant impact on the perceived value of independently investing firms. This similarity between the co-investing and independently investing firms in the price of the 5G network means that price does not affect consumers' continuance intention and the perceived value obtained from using 5G from certain telecom operators.

The post-purchase evaluation factor confirmation (H6) is positively related to satisfaction. Users who feel that their expectations of 5G services are satisfied are also more satisfied. However, system and service quality (H7) did not significantly impact the satisfaction of independent firms. This finding might indicate that for this group, other factors such as confirmation and value played a more prominent role in shaping satisfaction. Similar to the models above, the perceived value generated by 5G services (H4) positively affects consumer satisfaction with independent firms.

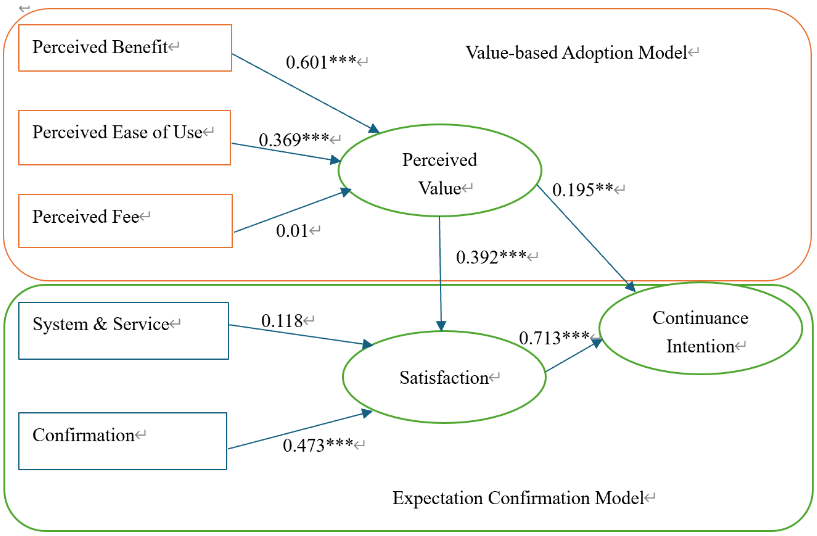

Fig. 4. Results summary for independently investing firm (***p<0.001; **p<0.05).

Table 7
Research model results for independently investing firms

Hypothesis	Sample mean	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
H1. Benefit→ Perceived Value	0.601	0.068	8.813	0.000
H2. Ease of Use→ Perceived Value	0.369	0.074	4.976	0.000
H3. Perceived Fee→Perceived Value	0.01	0.024	0.288	0.387
H4. Perceived Value→Satisfaction	0.392	0.085	4.617	0.000
H5. Satisfaction→Continuance Intention	0.713	0.1	7.238	0.000
H6. Confirmation→Satisfaction	0.473	0.068	6.954	0.000
H7. System &Service→Satisfaction	0.118	0.071	1.624	0.052
H8. Value→Continuance Intention	0.195	0.104	1.764	0.039

5.4.4 Outcome comparison for different groups

To assess differences in user behavior across telecom investment strategies, we conducted a MAG comparing consumers from co-investing and independently investing firms. The focus was on whether the structural relationships in the model—particularly those influencing perceived value, satisfaction, and continuance intention—varied significantly across the two groups. The results are summarized in Table 8, with statistical significance indicated for path coefficient differences. While most path differences were not statistically significant, two effects stood out: H1, this relationship was significantly stronger among users of independently investing firms, suggesting that functional gains such as productivity and entertainment more strongly shape their value perceptions; H2, conversely, this path was significantly stronger among users of co-investing firms, indicating that ease of use plays a more crucial role in shaping value perceptions under co-investment model. No significant group differences were found for other relationships, including H3, H4, H5, H6 and H7.

These results suggest that although satisfaction and perceived value are consistent drivers of continuance intention in both groups, the formation of perceived value differs depending on the investment strategy. Users of independently investing firms place greater emphasis on functional benefits, whereas users of co-investing firms are more influenced by ease of use. In contrast, price sensitivity and network quality do not exhibit differential effects, implying that users—regardless of investment model—share similar expectations once basic service quality is met. This highlights that while investment models may not reshape the overall structure of user loyalty, they do influence how users come to perceive value in 5G services.

Table 8

Multi-group analysis (***p<0.001; **p<0.05)

Hypothesis	Difference (co-investing -independently investing)	P values
H1. Benefit→ Perceived Value	-0.218**	0.02
H2. Ease of Use→ Perceived Value	0.189**	0.047
H3. Perceived Fee→Perceived Value	0.072	0.179
H4. Perceived Value→Satisfaction	-0.138	0.102
H5. Satisfaction→Continuance Intention	-0.102	0.183
H6. Confirmation→Satisfaction	0.035	0.384
H7. System &Service→Satisfaction	0.121	0.105
H8. Value→Continuance Intention	0.096	0.211

6. Discussion and implications

To the best of our knowledge, this study is among the first to integrate the Expectation-Confirmation Model (ECM) and Value-Based Adoption Model (VAM) to investigate post-adoption behavior in the 5G service context. It offers a novel perspective on how telecom infrastructure investment strategies shape user perceptions. The findings contribute to theory by showing that value drivers differ across investment models, enriching both technology acceptance and network economic literature. Consistent with Shah et al. (2021), our results confirm that satisfaction and perceived value are the primary drivers of user loyalty. Notably, price had no significant impact on perceived value, suggesting that users prioritize core functionalities such as speed, reliability and coverage over cost.

The multi-group analysis (MGA) revealed that although the effects of satisfaction and perceived value on continuance intention were stable across co-investing and independently investing firms, differences emerged in how users construct value. Users of independently investing firms derived higher value from functional benefits (e.g., productivity, entertainment), while users of co-investing firms responded more strongly to ease of use. These findings indicate that infrastructure investment strategies influence value formation, though not necessarily user loyalty. One possible explanation is that users have limited awareness of the investment model, reducing its impact on behavioral intentions. Co-investing strategies may affect costs or expansion plans, but not the user-facing aspects of service quality that shape-adoption behavior.

From a managerial perspective, these findings offer strategic insights for telecom operators. Regardless of investment model, maintaining high network quality and service reliability remain essential to support user satisfaction. However, differentiated strategies can enhance competitive positioning. Independently investing firms should emphasize value-added services, customized plans, or strong brand identity to enhance perceived value. Co-investing firms, in contrast, may benefit from focusing on streamlined user experience and platform simplicity, as ease of use significantly boosts perceived value among their customers.

By aligning strategic efforts with user-specific value perceptions, telecom operators can enhance customer retention and competitiveness in the evolving 5G landscape.

7. Limitations and future studies

This study provides appealing insights, although it possesses limitations that necessitate additional investigation. The ECM and VAM frameworks offer a robust base; however, including demographic variables such as gender or wealth might augment the model. Secondly, we only employ online questionnaires; future study should combine survey findings with in-depth interviews or focus groups to provide more profound insights into user continuing intention. The emphasis of our study on Chinese consumers restricts the generalizability of the findings. Future research with regionally diversified samples would be advantageous. This study employed a cross-sectional design. A longitudinal method would allow researchers to document changes in dissatisfaction and value judgments over time, especially as 5G technologies develop and advance.

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Appendix

Table A1

Descriptive information of the constructs in the research model

Perceived Benefit	N	Mean	Std. Deviation
PB1	508	4.27	0.941
PB2	508	4.28	0.94
PB3	508	4.29	0.886
PB4	508	4.27	0.958
Perceived Fee			
PF1	508	3.87	1.177
PF2	508	3.22	1.346
PF3	508	3.6	1.106
Ease of Use			
PE1	508	4.25	0.91
PE2	508	4.37	0.826
PE3	508	4.19	0.89
Perceived Value			
PV1	508	4.11	0.992
PV2	508	4.18	0.98
PV3	508	4.11	0.994
System &Service Quality			
SS1	508	4.13	1.017
SS2	508	4.17	0.971
SS3	508	4.29	0.92
Confirmation			
CN1	508	4.06	1.015
CN2	508	4.07	1.028
CN3	508	4.12	1.025
Satisfaction			
ST1	508	4.22	0.949
ST2	508	4.15	0.955
ST3	508	4.14	1.018
Continuance Intention			
CI1	508	4.31	0.893
CI2	508	4.2	0.949
CI3	508	4.2	0.999

Table A2
VIF values in inner model

	CI	CN	PB	PE	PF	PV	SS	ST
CI								
CN								3.185
PB						2.009		
PE						1.991		
PF						1.108		
PV	3.512							3.6
SS								4.203
ST	3.512							

5G continuance intensions survey questionnaire

Dear Sir/Madam

I am a PhD student at the Faculty of Business and Economics, University of Malaya. I am conducting a survey on 5G continuance intention in China. Thank you so much for taking the time out of your busy schedule to fill in this questionnaire.

Your contribution to this study is invaluable. We will keep all the feedback of the questionnaire confidentially, and promise to only conduct statistical analysis solely for research purpose.

Thank you for your time and cooperation.

Part 1: Basic Information

Your gender: ① Male ② Female

Your age:

Your current location:

What is your highest level of education completed?

①High School or less ②College Degree

③Bachelor’s Degree ④Master’s Degree

What is your current mobile network?

① 4G network ② 5G network

Which mobile network operator is providing the mobile network you are currently using?

①China Mobile ②China Telecom ②China Unicom

Part 2: Questions related to 5G continuance intention.

The questionnaire employs a 5-point Likert Scale. Please assess each question from your personal perspective. Use the scale provided, ranging from 1 (indicating “strongly disagree”) to 5 (signifying “strongly agree”), to indicate the degree to which each description aligns with your own experiences or beliefs.

Perceived Benefits

1. PB1: 5G is very helpful in my daily life.
2. PB2: 5G makes it easier for me to accomplish tasks.
3. PB3: 5G provides me with more entertainment.
4. PB4: 5G services are more useful compared to that of 4G.

Perceived Sacrifices

Perceived fee:

5. PF1: The cost for using 5G is expensive.

6. PF2 The services that 5G provides are time consuming.

7. PF3: Using 5G cause me a burden.

Perceived Ease of Use

8. PE1: 5G is easy to use.

9. PE2: Transitioning from 4G to 5G is easy for me to adapt.

10. PE3: Using 5G consumes a lot of energy.

Perceived Value

11. PV1: In relation to the spending of both time and money require, the utilization of 5G provides substantial value.

12. PV2: Considering all the advantages and disadvantages, I find the use of 5G beneficial.

13. PV3: perceive strong value in using 5G.

System and Service

14. SS1: The current telecom operator provides me with good customer service.

15. SS2: The current telecom operator has a wider 5G network coverage.

16. SS3: The quality of the 5G network I am currently using is high (e.g. stable in video call, upload and download speed)

Confirmation:

17. CN1: My experience with 5G has exceeded my expectations.

18. CN2: In general, my expectations for 5G have largely been fulfilled.

19. CN3: 5G has demonstrated greater functionality than I initially anticipated.

Satisfaction:

20. ST1: Overall, I am satisfied with 5G.

21. ST2: 5G meets my former expectations.

22. ST3: Using 5G gives me a great sense of satisfaction.

Continuance intention (CI)

23. CI1: I will continue using 5G after I use it.

24. CI2: I will continue using my current 5G network without switching to other operators.

25. CI3: I intend to recommend my current telecom operator's 5G service to friends and family.