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**Should I scan my face? The influence of perceived value and trust on
Chinese users' intention to use facial recognition payment**

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Should I scan my face? The influence of perceived value and trust on Chinese users' intention to use facial recognition payment

Abstract: Drawing on the perspectives of perceived value and trust, this study examines the factors affecting Chinese users' intention to use facial recognition payment (FRP) service. Data collected from 1200 Chinese mobile payment users is analyzed by using structural equation modelling. Results show that convenience positively influences perceived value; privacy risk and financial risk negatively influence perceived value. Only privacy risk and financial risk can significantly affect trust in FRP. Novelty has no significant effect on perceived value and trust. It is also found that perceived value positively influences trust, and both perceived value and trust are factors positively affecting intention to use FRP. Information sensitivity moderates the relationship between perceived value and intention to use FRP. Theoretical implications and practical implications are discussed.

Keywords: facial recognition payment; perceived value; trust; intention to use

1. Introduction

The maturity of biometric technology provides solid technical support for the proliferation of cashless payments worldwide (Burt, 2020; Harrison, 2021). Consumers in general are becoming familiar with mobile phone apps that unlock and verify payments using biometrics (i.e., facial recognition, fingerprints, iris scans or voice) (Jones, 2020). During the COVID-19 pandemic, people's concerns with health have evoked a prevalence of various digital payments (Harrison, 2021). In spite of the existence of skeptical voices due to fraud in authentication, the adoption of contactless payments using biometric technology is still growing (Burt, 2021). Juniper Research (2018) predicted that mobile biometrics would account for \$2 trillion in remote and in-store payments by 2023. In addition, facial recognition is anticipated to be more prominent in device adoption over the next five years. As users are increasingly able to perceive convenience and the value of biometric payment methods, the application of biometrics in mobile payments is expected to reshape the future of commerce (CCV, 2020).

As one of the novel biometric payment methods, facial recognition payment (FRP) has attracted wide attention as it provides an efficient and convenient payment process (Achim, 2020). In various scenarios, such as in restaurants and shops and on public transportation where FRP service has been activated, users only need to look into the cameras on related devices to complete their payments if they previously signed up for the service. In the eyes of technology giants and investors around the world, FRP is expected to be on the verge of significant growth. For example, Preciate, a face biometrics startup, has raised 5 million dollars to deploy FRP systems in markets in the U.S. and Israel (Burt, 2021). Two Russian retailers are testing or planning to launch

FRP in Russia's supermarket chains. A Canadian company named SnapPay has also announced plans to offer a new method of payment for merchants (Izvestia, 2020). However, booming investments may also give rise to potential risks. While individuals' biometric data is the most private part of everyone's data (Jones, 2020), facial information cannot be reset like a password or Personal Identification Number (PIN) once it is damaged. Therefore, users should be alert to the possibility of facial information being stolen and subsequently causing financial loss. Another possibility is that facial information might be used for third-party purposes, which not only poses a threat to the FRP users' financial security and privacy (Wiggers, 2020), but also increases distrust among them. A Pew Research Center (2019) survey echoed this view. It shows that only 36 percent of participants trusted tech companies to use facial recognition responsibly, and only 17 percent of participants trusted advertisers.

Owing to China's leading position in the application of facial recognition technology (Achim, 2020), it has become increasingly common for Chinese users to adopt FRP. It was reported that facial payment devices appeared in over 1,000 convenience stores in 2019. In addition, more than 100 million Chinese have registered to use this new payment method (CEO Magazine, 2019). Furthermore, the two most popular mobile payment platforms in China, Alipay and WeChat Payment, have made great efforts to promote FRP. By providing shopping rebates and discount coupons, the estimated cost incurred by Alipay in promoting FRP has been about 400 million dollars (Achim, 2020). However, compared with active stakeholders, Chinese users have expressed unease and distrust with regard to FRP. According to an online survey conducted by the Southern Metropolis Daily (2020), in spite of FRP being widely recognized for its convenience, people are also concerned about several risks such as the disclosure of facial information and property damage. In addition, although there has traditionally been less emphasis on personal privacy among Chinese than among their counterparts in other jurisdictions (Borak, 2021), data leaks and privacy issues are increasingly blocking users from using their faces to pay. The potential risks are leading to distrust in facial recognition systems, which has become a core issue impeding the acceptance of FRP (Liu, 2020).

Based on the two primary variables of perceived value and trust, this study aims to build an empirical model to explore significant factors influencing Chinese users' willingness to use FRP. In addition, to explore the psychological mechanisms of users when facing trade-offs, the main perceived benefits (i.e., perceived convenience and perceived novelty) and risks (i.e., perceived privacy risk and perceived financial risk) have been integrated into the current research model. Furthermore, information sensitivity as a moderating variable plays a role in our research framework. Thus, this study is expected to theoretically extend the theory of the perceived value to the new context of FRP. At the same time, it hopes to build a new framework to better understand users' perceptions and willingness to accept applications of new technologies.

2. The background to FRP in China

China has been playing a leading role in the technological accumulation and commercial use of FRP at the global level (Lee, 2017). Statista (2021) shows that China now globally has the biggest digital payment market, with its transaction volume reaching US\$2,496 billion in 2020. This value accounts for 45.6% of the global total. In terms of the number of active users of worldwide mobile payment platforms, WeChat and Alipay rank first and second. In addition to near field communication (NFC) payments, QR code payments and fingerprint payments, FRP provides another choice for users to enable them to have a better shopping experience, transforming business models to the new digital payment method (Zhong et al., 2021). China had 61 million FRP users in 2018, and this number may exceed 760 million in 2022 as predicted (Iimedia, 2019). The advances in software and hardware have laid a foundation for FRP's development, such as liveness detection, the 3D structured light camera and big data technology (Harvard University, 2021). Moreover, China is a pioneer in combining mobile network technology with biometrics. Support from telecom operators and the gradual commercialization of 5G technology have effectively brought about the prevalence of FRP (Pymnts, 2019). Meanwhile, the draft of the Personal Information Protection Law and industry standards for facial recognition have been released by the Chinese government and tech companies (Liu et al., 2021), marking tentative progress in the regulation of facial recognition (Lee, 2020). Although FRP has established a good foundation in China, the acceptance of the use of biometrics exhibited a significant decline during the pandemic, falling from 84.4% in 2019 to 82.6% in 2020 (STCN, 2021). Privacy issues and financial security concerns raised by facial recognition have also sparked heated discussions, involving themes such as false identities, the illegal collection of facial data and the leakage of various individuals' facial signatures (Tan, 2019).

In the current Chinese market, the FRP business is dominated by China's two largest Internet companies, namely, Tencent and Alibaba, which together account for a 90% market share (Iimedia, 2019). The two companies' mobile payment platforms (i.e., Alipay and WeChat Pay) have almost monopolized the FRP market. In March 2015, Alibaba's Executive Chairman Jack Ma demonstrated FRP at an IT fair in Germany (Fonsegrives, 2015). In September 2017, KFC's KPRO restaurant adopted Alipay's novel facial recognition payment solution referred to as "Smile to Pay" (YumChina, 2017). In December 2018, Alipay officially launched the facial payment machine "Dragonfly". Three months later, WeChat's face-scan payment device referred to as "Frog" was launched (GlobePay, 2020). These face-scan devices can be adapted to most merchants' cash registers, thereby lowering the barrier to the adoption of facial recognition systems (He, 2018). In addition, UnionPay, a Chinese financial services corporation with a state background, has also entered the fiercely competitive FRP market. It introduced its own facial-scan payment product referred to as "Blue Whale" in October 2019, which signaled FRP's widespread recognition as a mainstream payment approach in China (Jao, 2019).

Due to the prevalence of smartphones and e-commerce, third-party payment platforms such as Alipay and WeChat Pay have gained the upper hand over traditional payment methods since 2012, with user penetration rates reaching 70.9% and 86.4%, respectively (36Kr, 2019). By virtue of their huge user bases, these two platforms have gained much experience in cultivating users' new payment habits. In the early stage of promotion, both of them adopted a subsidy strategy to help merchants purchase hardware facilities for FRP (The Guardian, 2019). In April 2019 when the "Dragonfly" 2.0 version was launched, Alipay started to provide subsidies amounting to 3 billion RMB over three years, which were then increased to unlimited amounts in September of the same year. Compared with Alipay's subsidies policies, WeChat Pay required a lower minimum number of transactions, and the subsidy period was extended to March 2021 (Hibor.com, 2020). In addition, it also provided rewards for those using FRP (The Business Times, 2019). In sum, Alipay and WeChat Pay gave out more subsidies to support vendors in the FRP promotion period than it did for payments using QR codes (Hibor.com, 2020).

To alleviate users' worries and win their trust, the three major FRP platforms have added mobile verification codes for further security checks (China Hightech, 2019). In addition, Alipay has upgraded the algorithm for "Dragonfly" devices, increasing its processing speed by 30%. Users can make payments even in darkness, such as at night (Chinanews.com, 2019). At present, FRP is mainly applied in supermarkets, convenience stores and shopping malls, which recently accounted for 40.7% and 35.2%, respectively (Iimedia, 2019). Bao (2020) pointed out that FRP is expected to expand its application to vending machines and smart lockers, which will be helpful in exploring the office scene besides various consumption scenarios in daily life.

3. Literature review and research hypotheses

3.1 Related works on FRP in China

While a few studies have provided some preliminary findings on Chinese users' perceptions and acceptance of FRP, these findings have mainly to do with two aspects. First, the privacy trade-off in FRP has aroused considerable interest in recent years. Liu et al. (2021) combined the privacy calculus model with the concept of innovation resistance, and found that the perceived effectiveness of a privacy policy has a significant impact on privacy-related factors such as privacy control and perceived privacy risk. Li et al. (2020) proposed a research model integrating the merits of FRP with its privacy concerns, but they did not provide empirical results in their work. Second, scholars have examined various antecedents that promote usage intention in relation to FRP, with a particular focus on relevant factors concerned with system quality or the Technology Acceptance Model (TAM). For instance, Zhang et al. (2021) selected convenience, reliability, security and non-contact as the FRP's quality features, of which the first three factors have a negative impact on users' resistance. Zhong et al. (2021) demonstrated that those positive factors such as perceived enjoyment, facilitating conditions, coupon availability, and perceived ease of use can drive users' decisions regarding whether to adopt FRP on the basis of the TAM. Zhang and Kang

(2019) and Dong and Hai (2019) also selected the TAM as their major theoretical model. In their studies, they mainly focused on the impact of positive variables (e.g., security, visibility, expected effort, perceived usefulness and perceived ease of use) on usage intentions (see Table 1).

Previous research has examined a wide array of variables that can affect the adoption of FRP, but has not considered the perceived value of users after weighing the pros and cons in the overall panorama. Although Liu et al. (2021) and Li et al. (2020) conducted research on the user's FRP trade-off from a privacy perspective, a comprehensive analysis that incorporates the wider benefits and risks is still needed. Furthermore, the factor of trust in FRP has also been ignored, which is an issue that deserves an in-depth exploration at a time when Chinese users have exhibited signs of distrust towards facial recognition (Achim, 2020). Therefore, it appears to be both important and necessary to build a comprehensive model directed towards FRP that is based on perceived value and trust.

Table 1

Prior studies on the usage intention of FRP among Chinese users

Author	Theme	Theory	Method	Main Findings
Liu et al. (2021)	Resistance to FRP from privacy angles	Privacy calculus; Innovation resistance.	SEM	The perceived effectiveness of privacy policy is crucial to Chinese users' perception of privacy. Their perceived privacy risks positively affect perceived benefits.
Zhang et al. (2021)	FRP's features affecting innovation resistance and usage intention	Innovation resistance	PLS-SEM	One of FRP's features, namely, non-contact, positively affects users' innovation resistance. Besides, users' innovation resistance can negatively affect their usage intention.
Zhong et al. (2021)	Exploring several positive factors that push Chinese users to adopt FRP.	TAM	PLS-SEM	Financial incentives, the perceived enjoyment, appropriate technical support and resources can drive users to choose FRP.
Li et al. (2020)	Privacy calculus in usage intention of FRP	Privacy calculus; Protection motivation theory	Proposed SEM	This paper assumed that the privacy concerns and relative advantages can shape people's usage intention towards FRP. In addition, personal innovativeness is set as a moderator in the proposed

Zhang and Kang (2019)	Possible factors affecting usage intention of FRP	TAM Unified theory of acceptance and use of technology (UTAUT)	PLS-SEM	model. However, no empirical results were presented. The security, social image, the surrounding environment, and users' personality play key roles in the usage intention of FRP. Perceived usefulness plays a mediating role in the overall model.
Dong and Hai (2019)	Possible factors affecting the acceptance of FRP	TAM UTAUT	PLS-SEM	Subjective norms and system quality indirectly affect behavioral intention via perceived usefulness. Systematic quality and perceived enjoyment have an indirect impact on behavioral intention via perceived ease of use.

3.2 Perceived value

Perceived value is a well-established concept that has drawn much attention from scholars when they study customers' or users' decisions regarding a product or service. Drawing upon equity theory, the perceived value is intended to refer to the individual's overall assessment of the utility of an object based on perceptions of receiving and giving (Zeithaml, 1988). It is based on assessments between the sacrifices and gains (Bolton & Drew, 1991). Perceived value represents the collection of the benefits that users expect, as well as the potential undesired outcomes (Kumar & Reinartz, 2016). It is one of the most important factors in predicting consumers' perceptions and behaviors (Chang & Tseng, 2013; Hsiao et al., 2016).

As the concept of perceived value has developed, scholars have formed various definitions with different emphases. For example, from a monetary perspective, Bishop (1984) defined perceived value as the difference between the highest price that the consumer can accept and the actual amount paid. Sweeney and Soutar (2001), based on a framework proposed by Sheth et al. (1991), suggested that perceived value consisted of various aspects including functional value, emotional value, social value and other values. Zeithaml (1988) defined perceived value as the global assessment of gains and costs, a definition that has been widely adopted by much of the subsequent research since it sets the foundation for the conceptualization of perceived value (Petrick, 2002; Wong, 2014). In this paper, we define the perceived value of facial recognition payment as the users' overall evaluation of FRP on the basis of a trade-off between the perceptions of benefits and costs.

After perceived value emerged as a classic concept in the 1990s, it was largely used to explore consumers' purchasing behaviors (Sánchez-Fernández & Iniesta-Bonillo, 2007). As technology developed, this construct was employed by scholars to understand the user's decisions and behaviors in the contexts of various e-services and information systems, such as mobile offices (Seol et al., 2016), ride-sharing services (Wang et al., 2019), and also mobile financial applications (Karjaluoto et al., 2019). When faced with facial recognition payment, many Chinese users tend to weigh the pros and cons and decide whether to use it based on the overall assessment (Liu, 2020). Thus, this research considers perceived value to be a significant factor in the usage of facial recognition payments.

Perceived value has been examined to have good exploratory power in terms of user intention and the behavior of mobile applications. In the context of information systems, perceived value is defined as the total evaluation of a service, which can drive further behavior of users (Kim et al., 2007; Yu et al., 2013). In the formation process of perceived value, individuals assess the trade-off between the benefits and the costs of a service (Yang et al., 2012). After the evaluation, users will make a decision on whether to use this service or not. In previous research, scholars found that perceived value has a positive influence on users' behavioral intention (Hsu & Lin, 2015; Lin & Bautista, 2018; Yang et al., 2016). When faced with facial recognition payments, users also tend to make judgments on the total utility of this application. If they perceive it to be worthwhile, they will be more inclined to adopt this new technology. Thus, the following hypothesis is proposed:

H1: Perceived value will positively influence intention to use FRP.

3.3 Trust

Trust is a well-established construct that has been examined by different disciplines. In contexts that involve uncertainties and risks, such as online transactions, trust is regarded as a crucial factor (Reichheld & Scheffer, 2000). The definition of trust has to do with how much the individual is willing to be vulnerable to another party (Mayer et al., 1995), which can be understood as the perceived reliability, integrity and dependability of an object or a person (Doney & Cannon, 1997). Trust is built and developed by previous experience, long-term orientation and a feeling of control (Jarvenpaa et al., 1999). Moreover, the concept of trust is not only limited to interpersonal contexts, but is also important in interactions with technologies. Trust is tightly connected to the users' acceptance of new technologies (Kuriyan et al., 2010), and has been a focus of technology adoption, especially the technologies of e-commerce (Jarvenpaa et al., 1999; Park et al., 2019).

Trust is an important determinant of the success of e-commerce and m-business transactions, because customers are uncertain about the possible threats and risks (e.g., hacking and misuses of the system), which may occur in the process of online transactions (Chong et al., 2018; McKnight et al., 2002; Pavlou, 2003; Shaikh et al., 2021). In the context of online payments, trust means the degree of trustworthiness of

the service in the users' eyes (Gefen, 2002; Zhou, 2014). Trust is a core mechanism intensifying users' beliefs that the payment services providers have the capacity to overcome the possible risks (e.g., privacy issues, errors of transactions) and will provide reliable services (Dahlberg et al., 2003). The previous literature also shows that trust will enhance the positive perceptions and behavioral intentions of mobile payments (Luo et al., 2010; Thatcher et al., 2010). Since FRP is at its nascent stage, to its users the technology is characterized by different uncertainties, which may cause users to worry about its potential risks. Thus, we suppose that trust is a salient factor determining whether or not the users will accept the FRP technology.

H2: Trust will positively influence intention to use FRP.

Scholars have found that perceived value and trust are positively related (Harris & Goode, 2004; Singh & Sirdeshmukh, 2000). However, there is no definite and consistent consensus on the direction of this association. Some research argues that trust has an influence on perceived value (Sirdeshmukh et al., 2002). However, the other viewpoint on the linkage is that after the individuals perceive the value, they will form and develop trust (Harris & Goode, 2004). This perspective is supported by subsequent empirical studies that find that perceived value has an influence on trust (Chae et al., 2020; Hariguna et al., 2020; Karjaluoto et al., 2012). In considering that facial recognition is at a nascent stage, users may first perceive the functionality and risks of FRP and make an overall assessment of it, and then the trust may subsequently be built based upon this process. Thus, we propose that perceived value is an antecedent of trust in this study. Specifically, if users consider that the benefits outweigh the risks, they will have a positive overall evaluation of FRP, and will tend to place more trust in the technology. The following hypothesis is thus proposed:

H3: Perceived value will positively influence trust in FRP.

3.4 Perceived benefits

Convenience can be regarded as the users' perception of a service from the perspective of saving time and effort (Berry et al., 2002). For mobile applications and mobile platforms, convenience is deemed to be a unique benefit (Kim et al., 2010; Meuter et al., 2003) to the users. When consumers switch to mobile payments, convenience is an important consideration (Williams, 2018; Zhang & Prybutok, 2005). In previous research, convenience was found to have an important effect on improving the mobile payment users' experience and perception (Dahlberg et al., 2015; Humbani & Wiese, 2019; Thakur & Srivastava, 2014). When using FRP, users do not need to input a password or even carry their mobile phones. The whole process lasts less than 15 seconds. The convenience makes FRP preferable to alternative payment methods. Research also shows that convenience is closely related to the user's perceived value of the service (Ahn & Lee, 2019; Patro, 2019). Thus, we propose the following hypothesis:

H4a: Convenience will positively influence perceived value of FRP.

Novelty refers to the extent of the newness and uniqueness of a product or a service that makes it different from others (Im et al., 2015). As an important aspect of the product's creativity (Amabile, 1988), novelty can facilitate the individual's evaluation of the product or the service (Rubera et al., 2010). However, in previous studies, there is insufficient research that explores the impact of novelty on perceived value. In the context of cell phone and shoe purchases, Im et al. (2015) found that perceived novelty exerted a positive effect on perceived value, but this finding is not consistent and stable. They called for further studies on the relationship between novelty and perceived value. In subsequent studies, scholars have also found that novelty can significantly increase mobile financial users' perceived value (Karjaluoto et al., 2019) and customers' perceived value of the innovative product through the increased innovation perception (Albertsen et al., 2020). Since FRP is relatively speaking the latest payment method, the innovative dimension of this technology is salient when users perceive this technology. Thus, we propose the following hypothesis:

H5a: Novelty will positively influence perceived value of FRP.

To a large extent, the usefulness of a technology service is contingent upon the extent to which it can bring benefits to its users (Walker & Johnson, 2006). When users perceive the technology-enabled service as being more advantageous and preferable, their uncertainties will decrease, whereas their trust in the service will increase accordingly (Park et al., 2019). In previous studies, scholars found that beneficial factors can enhance users' trust in contexts of mobile commerce and transactions (Kim et al., 2008; Sfenrianto et al., 2018; Siau & Shen, 2003; Sun et al., 2014). In this research, we anticipate that the perceptions of FRP's benefits will help reduce the uncertainties of FRP and further stimulate the establishment of trust among mobile payment users. As an important benefit of new technology, convenience has been found to be a facilitator contributing to the trust in the service's usage (Kim et al., 2009; Koufaris & Hampton-Sosa, 2004). Meanwhile, a recent study (Talwar et al., 2020) found that the newness of information, as a type of perceived information quality, can increase the initial trust in mobile payment services. Thus, we propose the following hypotheses:

H4b: Convenience will positively influence trust in FRP.

H5b: Novelty will positively influence trust in FRP.

3.5 Perceived risks

Perceived risks refer to the possible negative outcomes of a new service or product (Bauer, 1960). When individuals perceive a high level of risk toward an object, they feel a higher degree of uncertainty and worry about the potential losses (Cox & Rich, 1964). The perceptions of the risks are significant hindrances to the users' decision-making and evaluation regarding the mobile service (Chang & Tseng, 2013; Wang et al., 2019). In this study, we define the perceived risks of FRP as the possible negative outcomes of using the FRP service that the users perceive. There have been differences in dimensions and aspects in previous studies when perceived risks have been operationalized due to the research topics. Among the various specific kinds of perceived risks, privacy risk and financial risk are two that are significantly and

fundamentally related to internet services (Featherman & Pavlou, 2003). In the context of FRP, privacy risk and financial risk are the two most salient risks that users worry about (Liu, 2020).

Privacy risk reflects users' concerns that the service provider will maliciously collect and misuse personal information (Nyshadham, 2000; Gao et al., 2015). When using mobile payments, users will disclose private information, like contact numbers, demographic information and other personal information to the applications either consciously or unconsciously. Privacy risk reflects users' perceptions of potential negative outcomes, including collecting, transmitting and selling the information of individuals (Dinev et al., 2013). It is one of the most vital concerns for users of mobile payments (Martin & Shilton, 2016). Privacy risk has been found to decrease the users' perceived value of mobile payment services (Yang et al., 2015). FRP service requires users to provide facial information that it will store it in its database, which is really sensitive to users (Wilkinson, 2020). In a recent study on FRP, Liu et al. (2021) found that privacy risk is a significant factor increasing users' resistance to FRP. When users perceive a high level of privacy risk in relation to FRP, they will tend to lower their assessment of this new payment method. Thus, we propose the following hypothesis:

H6a: Privacy risk will negatively influence perceived value of FRP.

Financial risk refers to users' perceptions regarding the potential monetary loss related to using the service or product (Featherman & Pavlou, 2003; Grewal et al., 1994). Financial risk is an important concern for mobile payment users. Transactions in mobile payment services are often based on wireless communication technologies, which increase the potential risks of losing money due to account information theft (Yang et al., 2015). In previous studies, scholars found that financial risk negatively influences perceived value (Kim et al., 2007; Turel et al., 2010). With regard to FRP, the users only need to look into the camera to pay the bill, and the process only lasts a few seconds. The users are worried that some hackers may store their facial information and then steal the money in their accounts. The financial risk will lower their assessment on FRP since it brings higher uncertainty related to monetary loss. Thus, we propose the following hypothesis:

H7a: Financial risk will negatively influence perceived value of FRP.

Trust is interwoven with the perceived risk (McAllister, 1995; Tan & Thoen, 2000). According to (Mayer et al., 1995), individuals may need to take related risks when engaging in actions based on trust. According to this argument, studies have suggested that trust is based upon the degree of risk (Bansal & Gefen, 2010; Dinev & Hart, 2006). The perceived risks of the mobile service are closely related to the uncertainties (Kim et al., 2008) and hinder the formation and development of trust (Slade et al., 2015). If the risks and uncertainties are alleviated, then users would put more trust in the technological service. The relationship between perceived risk and trust has been examined in previous research (Eiser et al., 2002; Liao et al., 2011; Zhou, 2013), including mobile payment services (Park et al., 2019). To be specific, scholars have

found that users' trust in mobile payment services will decrease as they become more concerned about the higher risks associated with the financial aspects (Sarkar et al., 2020) and privacy (Khasawneh et al., 2018). If users perceive a high level of risk of FRP, they may distrust the technology. Thus, we propose two hypotheses as follows:

H6b: Privacy risk will negatively influence trust in FRP.

H7b: Financial risk will negatively influence trust in FRP.

3.6 Information sensitivity

Information sensitivity is defined as the degree of discomfort when a person discloses personal information to a specific agency (Dinev et al., 2013), which largely depends on the types of information requested by a firm or platform (Malhotra et al., 2004; Sheehan & Hoy, 2000). Although an ordinary facial image does not fall within the scope of personal private information, facial recognition technology can connect the personal picture with other identities (e.g., age, gender, financial information) without necessarily acquiring the users' consent (PrivacyRights Clearinghouse, 2011). In particular, users in China have expressed concern about the information-gathering requirements of FRP (Li et al., 2020; Liu et al., 2021). Considering the uniqueness of FRP, in the current study, when we use information sensitivity, we specifically refer to facial information sensitivity, which refers to the extent to which users feel uncomfortable when they provide facial information to use FRP.

Information sensitivity has also been proved to interact with people's perceptions and beliefs to influence the subsequent outcomes. Kehr et al. (2015) found that when consumers use new smartphone applications, the perceived sensitivity of information is closely related to the rational assessment process towards privacy-related decision-making, that is, higher information sensitivity may increase negative perceptions but reduce positive perceptions. It is noted that the information sensitivity in this case has an impact on the situational privacy calculus, instead of affecting a comprehensive trade-off for users. In addition, Yang and Wang (2009) found that, in the context of online marketing, the interaction between information sensitivity and compensation can affect consumers' behavioral intentions, which is consistent with the findings of Malhotra et al. (2004). They found that consumer responses are compounded by contextual factors such as the level of information sensitivity and the value or reward offered by merchants (Phelps et al., 2000).

In fact, perceived sensitivity has been used as a moderating variable to influence the relationship between perceived value and users' purchase intention (Song et al., 2019). For example, Petrick (2005) pointed out that for travel customers, the higher the perceived price sensitivity, the higher the perceived value of travel. However, customers with low price sensitivity are more likely to continue buying products or services from travel providers, since such users are more likely to address facial information sensitivity than price, and information sensitivity is a highly subjective and situational factor (Malhotra et al., 2004; Sheehan & Hoy, 2000). Based on that, this study proposes that there may be differences in the mechanism underlying the

formation of intention to use FRP among individuals with different levels of facial information sensitivity. Therefore, we put forward two research questions:

RQ1: How does facial information sensitivity moderate the relationship between perceived value and intention to use?

RQ2: How does facial information sensitivity moderate the relationship between trust and intention to use?

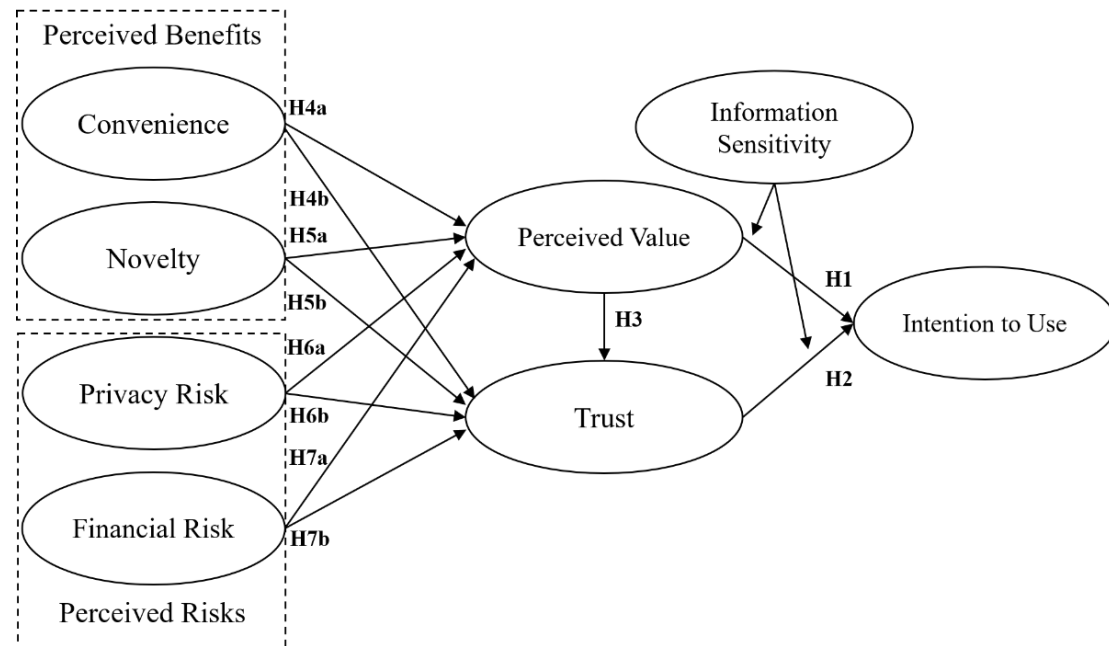


Figure 1
Research model

4. Research Methodology

4.1 Data collection

The purpose of this study is to explore the antecedents influencing the user's intention to use FRP. To this end we collected data from current mobile payment users in China. To be specific, users of mobile payment platforms that offer facial recognition payment service as an option for their users, such as Alipay and WeChat Pay, were targeted participants in this research. The data was collected with the help of a professional research company named IPSOS, which has a large amount of registered sample resources. To ensure the quality of the data, a filter question was set at the beginning of the questionnaire to exclude those participants who were not mobile payment users. Then the purpose of the research was shown in the questionnaire. After a one-month data collection period from August to September 2020, a total of 1,200 valid responses were obtained. Table 2 shows the demographic profile of the participants.

Table 2

Descriptive statistics of participants' demographic information

Variables	Category	Frequency (%)
Gender	Male	549 (45.8%)
	Female	651 (54.3%)
Age	18-25	360 (30%)
	26-34	306 (25.5%)
	35-49	306 (25.5%)
	50 or above	228 (19.1%)
Education	High school degree or below	129 (10.8%)
	Junior college	312 (26%)
	Bachelor's degree	702 (58.5%)
	Master's degree or above	57 (4.8%)
Usage experience of mobile payment	2 years or below	259 (21.6%)
	3-4 years	343 (28.6%)
	5-6 years	352 (29.3%)
	7 years or above	246 (20.5%)
Usage frequency of mobile payment (time/week)	0-3	40 (3.3%)
	4-7	283 (23.6%)
	8-14	346 (28.8%)
	15-21	283 (23.6%)
	22-28	117 (9.8%)
	29 or above	131 (10.9%)
	3000 or below	197 (16.4%)
	3001-5000	163 (13.6%)
Monthly income (RMB)	5001-7000	306 (25.5%)
	7001-10000	209 (17.4%)
	10001-12000	182 (15.2%)
	12001 or above	143 (12%)

4.2 Measurement

The measurements of the research constructs in our study were adapted from validated instruments in previous research. The items used to measure the constructs were adjusted to the context of facial recognition payment. The original questionnaire was in English, and we translated it into Chinese since the survey was administered in China. The participants were asked to show the degree of their agreement or disagreement with the items using a five-point Likert scale ranging from 1 (totally disagree) to 5 (strongly agree). Prior to the formal collection, we conducted a pilot test with a sample of 70 Chinese mobile payment users in July 2020. The results demonstrated that the scales were valid and reliable. The measurement items are provided in Table 3.

Table 3

Measurement items

Constructs	Measurement Items	Sources
Convenience	CO1: Using FRP would allow me to save time during my shopping CO2: Using FRP would be a convenient way to do shopping CO3: FRP is convenient because I can use it anytime CO4: Using FRP is expedient since it doesn't need a password	Pal et al. (2015); Kim et al. (2010)
Novelty	NO1: Using FRP offers novel experiences NO2: FRP can be considered as revolutionary NO3: FRP is really out of the ordinary	Im et al. (2015); Dang (2020)
Privacy Risk	PR1: There would be too much uncertainty associated with giving my personal information to FRP platforms PR2: Using FRP is risky in that unauthorized people could access my personal information PR3: Using FRP could make my privacy available to unknown individuals or companies without my knowledge	Featherman and Pavlou (2003); Yang et al. (2015)
Financial Risk	FR1: Using FRP can cause financial risk FR2: Malicious and unreasonable charging may occur if I use FRP FR3: The use of FRP could lead to a surprising loss on the capital account	Featherman and Pavlou (2003)
Perceived Value	PV1: There are greater benefits than disadvantages of using FRP PV2: Considering the cost, risk, and benefits, I think it is valuable to use FRP PV3: Despite the time, effort, and capital involved in FRP, they are worthwhile to me PV4: Overall, the use of FRP provides me with good value	Kim et al. (2007)
Trust	TR1: I trust that the technological advances in FRP make it reliable TR2: The FRP service is trustworthy TR3: Overall, I trust FRP	Srivastava et al. (2010); Zhou (2013)
Information Sensitivity	IS1: I do not feel comfortable with the type of personal information FRP platforms request from me IS2: I feel FRP gathers highly personal information about me IS3: The facial information I should provide to use FRP is very sensitive to me	Dinev et al., 2013
Intention to Use	IU1: Given a chance, I intend to adopt FRP IU2: I am willing to use FRP when it is available to me IU3: I plan to use FRP in my daily life IU4: I am likely to use FRP in the near future	Venkatesh et al. (2003); Schierz et al. (2010)

5. Results

5.1 Measurement model

This study used AMOS 22.0 software to validate the measurement model. To examine the reliability, convergent validity and discriminant validity, we conducted confirmatory factor analysis (CFA). The composite reliability (CR) and Cronbach's α were employed to evaluate the reliability of the constructs. The reliability is acceptable if both values exceed 0.7 (Hair et al., 1998; Reuterberg & Gustafsson, 1992). The convergent validity is achieved if the average variance extracted (AVE) is greater than 0.5 (Fornell & Larcker, 1981). As presented in Table 4, the CRs and Cronbach's α values of all the eight constructs were higher than 0.7, and all the AVEs exceeded 0.5. These results suggest that the reliability and the convergent validity are acceptable. Moreover, the discriminant validity is acceptable if the square root of the AVE of each construct is greater than the correlation values with other constructs (Fornell & Larcker, 1981). As shown in Table 5, the discriminant validity is sufficient.

Table 4

Scale properties of the measurement model

Construct	Item	Standard loading	Cronbach's α	CR	AVE
Convenience	CO1	0.728	0.803	0.807	0.512
	CO2	0.748			
	CO3	0.644			
	CO4	0.736			
Novelty	NO1	0.683	0.764	0.759	0.513
	NO2	0.677			
	NO3	0.785			
Privacy Risk	PR1	0.858	0.904	0.906	0.762
	PR2	0.888			
	PR3	0.873			
Financial Risk	FR1	0.844	0.873	0.874	0.698
	FR2	0.835			
	FR3	0.827			
Perceived Value	PV1	0.753	0.886	0.887	0.663
	PV2	0.848			
	PV3	0.804			
	PV4	0.849			
Trust	TR1	0.802	0.867	0.869	0.688
	TR2	0.811			
	TR3	0.873			
Information Sensitivity	IS1	0.758	0.835	0.844	0.645
	IS2	0.742			
	IS3	0.900			

Intention to Use	IU1	0.785	0.907	0.909	0.714
	IU2	0.836			
	IU3	0.863			
	IU4	0.891			

Table 5

Discriminant validity

Construct	CO	NO	PR	FR	PV	TR	IS	IU
CO	<i>0.716</i>							
NO	.709**	<i>0.716</i>						
PR	-.286**	-.189**	<i>0.873</i>					
FR	-.338**	-.289**	.785**	<i>0.835</i>				
PV	.592**	.514**	-.545**	-.581**	<i>0.814</i>			
TR	.557**	.504**	-.607**	-.644**	.781**	<i>0.830</i>		
IS	-.236**	-.149**	.649**	.554**	-.466**	-.445**	<i>0.803</i>	
IU	.595**	.547**	-.451**	-.538**	.804**	.763**	-.393**	<i>0.845</i>

Note: Values in italics represent the square root of the AVEs

5.2 Structural model

We employed structural equation modeling (SEM) to examine the research model. To evaluate the appropriateness of the model, the fit indices were assessed by means of the ratio of χ^2 and degrees of freedom, the root mean square error of approximation (RMSEA), goodness-of-fit (GFI), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI) and normed fit index NFI. The recommended and actual values of these indices are shown in Table 6. All the indices satisfied the requirements, showing that the model fit was good.

Table 6

Measurement model and Structural model goodness-of-fit indices

Fit indices	χ^2/df	RMSEA	GFI	AGFI	CFI	NFI
Recommended guidelines	<5	<0.08	>0.9	>0.9	>0.9	>0.9
CFA	3.781	0.048	0.931	0.912	0.964	0.952
Structural model	3.741	0.048	0.940	0.924	0.969	0.958

The results of the hypothesis testing are shown in Figure 2 and Table 7. Except for three of the hypotheses, all the other hypotheses were supported. Convenience, privacy risk and financial risk can significantly influence perceived value whereas novelty has no significant effect. Only the two factors of perceived risk can significantly negatively influence trust. However, neither convenience nor novelty can significantly affect trust. Perceived value can significantly influence trust. Both of them can significantly influence the intention to use FRP.

Table 7

Results of the hypothesis testing

	Path	Estimate	CR	p	Result
H1	PV→IU	0.679***	10.966	0.000	Supported
H2	TR→IU	0.245***	4.227	0.000	Supported
H3	PV→TR	0.620***	14.386	0.000	Supported
H4a	CO→PV	0.458***	3.887	0.000	Supported
H4b	CO→TR	-0.036	-0.350	0.726	Not Supported
H5a	NO→PV	0.076	0.641	0.521	Not Supported
H5b	NO→TR	0.183	1.828	0.068	Not Supported
H6a	PR→PV	-0.144*	-2.014	0.044	Supported
H6b	PR→TR	-0.149*	-2.489	0.013	Supported
H7a	FR→PV	-0.324***	-4.480	0.000	Supported
H7b	FR→TR	-0.138*	-2.174	0.030	Supported

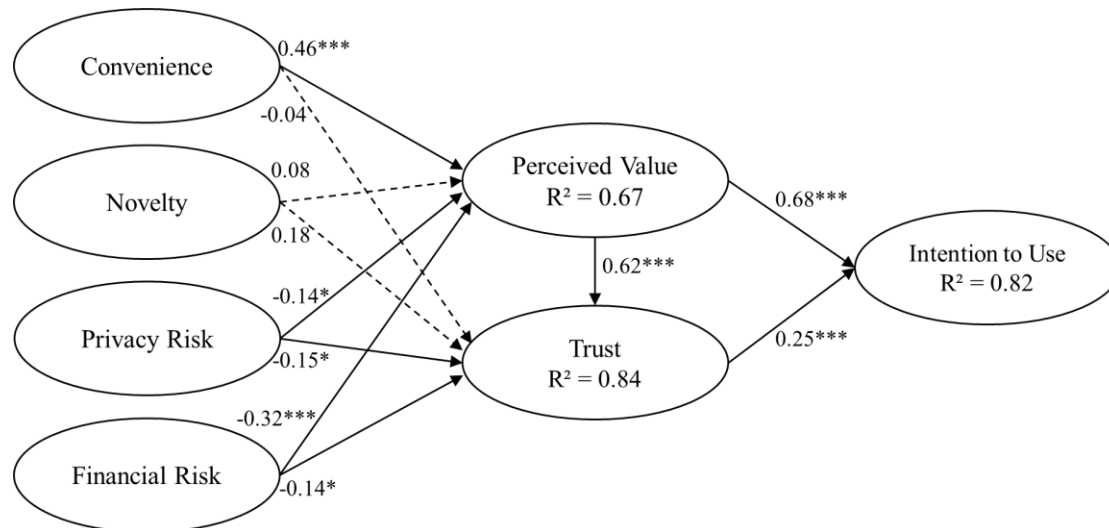


Fig 2

The results of the hypotheses

5.3 Moderating effect

To explore the moderating effects of information sensitivity, we used SmartPLS with the standard bootstrapping procedure with 2,000 samples. The reasons why we chose SmartPLS to examine the moderating effects are as follows. First, PLS is a structural equation modeling technique that uses latent variables for path analytic modeling (Chin et al., 2003), and the moderating variable in our research model is also a latent variable. Second, our hypothesized moderating effects of information sensitivity are exploratory in a broad sense, and have not been fully validated. In such a case, PLS-SEM is the recommended approach (Hair et al., 2016). Moreover, SmartPLS has been widely used in previous research as a useful way of testing the moderating effect of latent variables in structural equation models (e.g., Gong et al., 2019; Yu et al., 2019). Thus, we chose SmartPLS to explore our two research questions.

The results showed that the two moderating paths are different. The path of $PV \times IS$ to IU was significant ($\beta = 0.087$, $t = 2.119$, $p = 0.034$) whereas the path of $TR \times IS$ was nonsignificant ($\beta = -0.003$, $t = 0.088$, $p = 0.930$). This indicates that information sensitivity has a positive moderating effect on the relationship between perceived value and the intention to use. To interpret the significance of the interaction between perceived value and information sensitivity, we plotted the interaction effect to interpret the influence of perceived value on the intention to use under either a low or high level of information sensitivity. As can be seen in Fig 3, when a user regards the facial information that FRP requires as highly sensitive, the positive influence of perceived value on intention to use FRP increases. However, the influence of trust on intention to use is not moderated by information sensitivity.

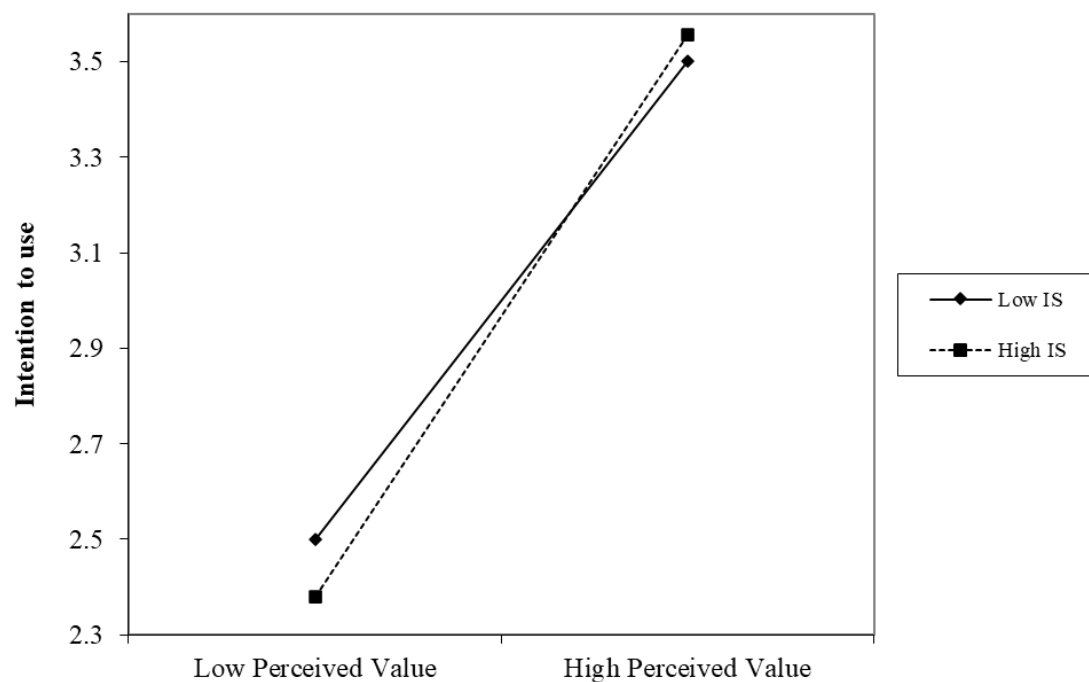


Fig 3
Plot of the relationship between perceived value and the intention to use at two levels of information sensitivity

6. Discussion and conclusion

6.1 Key findings

This study has built a research model to explore users' intention to use FRP by combining the perspectives of perceived value and trust. The antecedents can explain 82% of the variation in the intention to use. The results provide some interesting findings that unveil the mechanisms behind the users' perceptions and acceptance of the new payment technology. The most interesting findings are described as follows.

The current study not only provides further support for the impacts of perceived value and trust in scenarios for new technology acceptance, but also presents evidence to show that perceived value exerts an influence on trust. As expected, we found that

perceived value and trust are two significant facilitators of intention to use FRP. This is consistent with previous studies that emphasize the important effects of perceived value (Lin et al., 2020; Yang et al., 2016) and trust (Sarkar et al., 2020) on users' usage intention in the context of mobile payments. Meanwhile, in alignment with previous research on different topics (Chae et al., 2020; Karjaluoto et al., 2012; Liébana-Cabanillas et al., 2013; Singh & Sirdeshmukh, 2000), this study shows that perceived value can increase users' trust in FRP. If users assume that it is worthwhile to use FRP after comparing and evaluating its pros and cons, they will subsequently place more trust in the new payment technology. As the latest payment method, FRP has advantages that can positively influence mobile payment users' assessments (Zhong et al., 2021). Once users form positive evaluations of the mobile monetary service, the uncertainties may also be alleviated (Bauer et al., 2005; Namahoot & Laohavichien, 2018), which contributes to the formation and development of trust.

Meanwhile, this study found that convenience, privacy risk and financial risk are three significant antecedents of perceived value, whereas novelty has no effect on perceived value. The finding about the positive influence of convenience on perceived value is consistent with previous research (Ahn & Lee, 2019; Patro, 2019). Convenience is one of the most important factors of mobile commerce services for users (Mombeuil, 2020; Williams, 2018; Xu & Gutiérrez, 2006), and it can provide the utilitarian value perceived by users (De Kerviler et al., 2016). Facial recognition payment brings convenience in that it does not require users to perform any operations on their own devices to finish the payment process. Thus convenience is a prominent benefit that can improve users' evaluation of this service. As regards the risks, it has been found in previous research that perceived risks have a negative influence on perceived value (Karjaluoto et al., 2019; Patro, 2019). Privacy risk and financial risk are two salient risks regarding mobile payment services (De Kerviler et al., 2016). However, our results indicate that novelty cannot influence perceived value, which is inconsistent with the previous literature (Albertsen et al., 2020). This suggests that when users are evaluating FRP, the convenience and the risks are more important than the novelty. As the various applications based on facial recognition technology penetrate into people's daily lives, users are becoming more familiar with this innovative technology. Under these circumstances, the novelty itself cannot improve the perceived value of FRP. Our findings regarding the antecedents of perceived value are consistent with the previous literature, demonstrating that the relative advantages and potential risks are important factors in the context of mobile payments (Johnson et al., 2018; Jung et al., 2020).

The study has also found that only perceived risks rather than perceived risks and perceived benefits can influence trust. Specifically, financial risk and privacy risk can negatively influence trust, whereas neither convenience nor novelty can affect trust. This finding of a negative association between risks and trust is in accordance with previous studies (Chin et al., 2018; Khalilzadeh et al., 2017). As the latest payment method based on individuals' facial information, FRP brings a lot of worries in regard to privacy and financial risks. When there are uncertainties, the risks are exacerbated

(Kim et al., 2008) and become significant barriers hindering trust in FRP. According to previous studies, trust in services can be influenced by the perceptions of specific benefits like convenience (Sfenrianto et al., 2018). However, our research provides different results in that neither convenience nor novelty has significant effects on trust in FRP. A possible explanation is that other alternative payment methods also have similar advantages, and thus the benefits of FRP are not unique or sufficiently important to influence users' trust. Besides FRP, there are many different alternative payment methods in mobile payment applications, including passwords, QR codes, near field communication (NFC) and others. If we take NFC as an example, this new-developed technology provides a convenient contactless payment process by allowing "tap and go" transactions at point-of-sale (POS) terminals (Pu et al., 2020). Compared to these payment methods, FRP is not irreplaceable in terms of its benefits. Meanwhile, as we discussed above, novelty may not be the main demand of mobile payment users. Therefore, the two benefits are not salient enough to directly arouse and enhance users' trust in FRP. It is perceptions of risk that play a determining role in trust in the context of FRP.

Lastly, we have found that information sensitivity will moderate the effect of perceived value on the intention to use FRP. To the best of our knowledge, this is the first study to reveal the moderation effect of facial information sensitivity in the context of FRP. As a key variable, information sensitivity has been repeatedly verified as being an important factor affecting users' perceptions, trust and behavioral intention in the previous literature (Malhotra et al., 2004; Mothersbaugh et al., 2012). Generally speaking, when users perceive the information as being highly sensitive, they tend to be unwilling to disclose their information (Dinev et al., 2013; Lippert & Swiercz, 2007; Whiddett et al., 2006; Yang & Wang, 2009). Our research has found that the impact of perceived value on the intention to use is stronger among people who are more sensitive to facial information. Such people attach great value to their facial information. Under these circumstances, once they finish their evaluation and come to the conclusion that it is worthwhile disclosing their facial information in order to use FRP, they will develop a higher degree of usage intention. This implies that there might be differences in the mechanism behind the acceptance of a new technology among different groups.

6.2 Theoretical implications

By proposing a theoretical framework including perceived benefits, perceived risks, perceived value and trust to understand users' intention to use FRP, this study has important theoretical implications and adds to the body of knowledge on the acceptance of facial recognition payment.

First, by combining perceived value and trust together, this study has theoretical contributions regarding these two constructs. This paper has identified the enablers and barriers that affect users' perceived value and trust in the context of FRP. The findings have both similarities and differences with previous research. In a departure from the previous literature, our results show that novelty has no effect on perceived value and

neither of the two kinds of benefits can improve the trust in FRP. The results also show that the important factors influencing perceived value and trust may vary with different scenarios, so that when looking into the antecedents of these two constructs the specific context should be considered. Moreover, our research provides further evidence that perceived value has an impact on trust, which supports the viewpoint in previous research (e.g., Chae et al., 2020; Karjaluoto et al., 2012) that a positive evaluation can increase trust in an object.

Secondly, this paper adds to the discussion in the existing literature on facial recognition payment. It is the first attempt to combine perceived value and trust together to explore the users' acceptance of FRP, the latest biometric payment method. The proposed research model reveals good explanatory power on the intention to use. FRP is a new payment method with both pros and cons for mobile payment users. In a way that differs from the previous literature on facial recognition payment, we have introduced perceived value into our model to capture the users' assessment after comparing the potential benefits and risks. The significant influence of perceived value on the intention to use demonstrates that it is a prominent factor in the acceptance of FRP. Meanwhile, our research further proves the importance of trust in FRP, which is aligned with the fact that distrust is clearly a hindrance to the adoption of FRP (Liu, 2020). As for the antecedents, we found that novelty cannot affect perceived value and trust in the FRP context. Distinct from other cases, FRP is a more utilitarian mobile payment technology. To the users, whether the service is novel or not is not so important in terms of its ability to improve users' assessment and trust.

Finally, our study found that the effect of perceived value may differ among individuals with different levels of facial information sensitivity. In previous research on perceived value, few studies took into consideration differences among individuals. Given that FRP is unique in terms of its need to obtain facial information to use this technology, which is a sensitive issue among individuals (Liu et al., 2021), we added facial information sensitivity to our research model and found its moderating effect. This implies that the effect of perceived value may be based on individual characteristics in some cases. Subsequent research on perceived value can also take this into consideration.

6.3 Practical implications

This study also provides useful practical implications for improving the acceptance of facial recognition payment technology. Since perceived value and trust are two important factors that facilitate the intention to use, efforts can be made by service providers to improve the user's evaluation of and trust in FRP. To be more specific, the providers can emphasize the factors that significantly influence the perceived value and trust. The mobile payment platforms should keep developing and updating FRP to shorten the operating time and ensure network stability, because users attach greater value to utilitarian benefits like the convenience of FRP as opposed to novelty. In addition, one thing that the providers should bear in mind is that the potential negative

perceptions exert more powerful influences than the potential benefits (Kim et al., 2007). Thus, the platforms can focus on how to reduce the perceived risks of this technology. Regarding the privacy risk, the platforms need to provide a clear and detailed privacy policy to users when suggesting that they activate this new function (Liu et al., 2021). In addition, the encryption system should be improved to avoid the potential financial risks associated with users' mobile payment accounts.

Meanwhile, providers should realize that the effect of perceived value on the intention to use may differ among users with different levels of information sensitivity, whereas the effect of trust will not be influenced. In the promotion of this technology, diverse strategies may be adopted when facing different groups. When promoting FRP to users who consider the facial information to be sensitive, the promoters can show the perceived benefits that FRP may bring to improve their perceived value. Meanwhile, regardless of how sensitive users may consider the facial information to be, the providers should show that they have adopted efficient methods to reduce the potential risks of FRP.

6.4 Limitations and future research

This study also has some limitations. Since we employed a survey as our research method, this cross-sectional design may not be able to demonstrate the causality of the research model. In the future, researchers could conduct longitudinal research to better understand the users' intention to use FRP. In addition, this study was conducted in a Chinese society and there may be differences in the relationships among the variables in different societies. Scholars could also consider cross-cultural studies to explore whether the conclusions are consistent in different countries or cultures. Because our study mainly focuses on facial recognition payment, researchers could consider a comparative study by measuring users' perceptions of different mobile payment methods simultaneously to examine whether there are any discrepancies in the research results among the various payment options.

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