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# Factors Affecting the Use of Facial-Recognition Payment: An Example of Chinese Consumers

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**ABSTRACT** The emergence and use of facial-recognition payment technology has brought new challenges. Although credit-card payment is quick and easy, it is easy to lose a card or forget the password. Because people use simple passwords and reuse them on different accounts and services, passwords can be shared and cracked. QR payment is inseparable from smart phones, smart phones may be lost, signals may be unstable, and batteries may be exhausted. However, facial-recognition technology, which detects and describes feature vectors without physical contact, directly contributes to overall efficiency, performance, and accuracy. Currently, studies of technical issues of facial-recognition technology and facial-recognition payment systems are very popular. There are many studies that emphasize the working principle of the facial-recognition system, the system's reliability, and the future development trend. However, for non-technical issues, such as from the perspective of consumers, research on the characteristics of facial-recognition payment and the factors affecting consumer's intent to use is rare. Therefore, the purpose of this study is to explore the factors influencing consumers' willingness to use facial-recognition payment systems. This study has selected security, visibility, and expected effort and social image as the feature variables of the facial-recognition payment system. Results in this paper shows that the safety, security, visibility and social image will affect consumers' intent to use the system. It can also influence consumers' intent to use through perceived usefulness. The amount of effort expected not only has direct influence on intent to use but also influences the intent to use by the mediating factor of perceived usefulness. In this article, Openness characteristic (consumer's personality) has a moderating effect on the relationship between security, expected effort and usage intention.

**INDEX TERMS** Facial-recognition payment system, perceived usefulness, openness, intent to use.

## I. INTRODUCTION

At present, various simple and convenient payment methods are used by people, such as credit cards, QR code payment, and mobile payment. Facial-recognition payment based on biometrics has emerged. In Human-Robot Interaction (HRI), quick and efficient Facial-recognition techniques are often required in service robots Vinay *et al.* [1]. A facial-recognition system consists of several modules for image acquisition, feature extraction, matching, and a database Unar *et al.* [35] Facial-recognition is a technique for capturing human images (query images) and comparing them to previously recorded images in a database (Pratibha *et al.* 2016). The emergence of facial-recognition payment gives people a new technological experience. Face-related technologies have been widely used in many fields. In order to further improve the high-quality experience that technology brings, scientists have made one new break through after another in the field of face-related technology Hong *et al.* [89]. Facial-recognition is one of the few biometric methods that possess the merits of both high accuracy and low intrusiveness Lin [81]. The use of biometrics brings a more secure and convenient authentication method than traditional passwords (Esteban Daniel 2016). Biometric properties are not lost, transmitted, or stolen. Because these properties require the presence of real users when granting access to specific resources, they provide better security Unar *et al.* [35]. Among all the biometric techniques, face recognition possesses one great advantage, which is its user-friendliness (or non-intrusiveness). Facial-recognition systems are used in a

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wide variety of places, including airports, shopping malls and online, to establish peoples' identity Heyer *et al.* [80].

Facial-recognition in unconstrained images is at the forefront of the algorithm perception revolution. The social and cultural effect of face recognition technology is profound, but the performance gap between machine and human visual systems in this field can mitigate these effects, according to Taigman *et al.* [104] whose method reached an accuracy of 97.35% on the Labeled Faces in the Wild (LFW) dataset, reducing the error of the current state of the art by more than 27%, closely approaching human-level performance.

Several studies emphasize the working principle of the facial-recognition system, the system's reliability, and the future development trend. For example, Dmytro and Sukno [13] investigates the problem of Facial Expression Recognition (FER) using 3D data. Using facial markers as supplemental information in facial images can improve the accuracy of the personal identification process Becerra-Riera *et al.* [20]. Fei *et al.* [26] studied the overall development of facial-recognition technology, and they pointed out that 3D recognition technology provides relatively reliable identification technology. Moreover, Martins *et al.* [34] showed that DEM can provide 3D disparity maps for identification and verification, and can even handle a wide variety of facial expressions. Some scholars have studied the application of facial recognition technology in the field of life. Network access control via face recognition was studied by Lin [81], who points out that facial-recognition technology is one of the few biometric methods that have the merits of both high accuracy and low intrusiveness. Additionally, Bhatia [78] had studied the facial-recognition technology and other identification technologies, and summarized the advantages and disadvantages of each technology.

Few studies have explored the facial-recognition payment system characteristics that influence customers' intent to use. Few studies have looked at consumers' willingness to facial-recognition payment. Kim *et al.* [57] take Korean consumers as research subjects and find that consumers most prefer using cards for offline payments, followed by mobile and biometric payments. The possibility of personal information leakage, checkout time, cost of use, and the ratio of infrastructure are the main factors that influence customers' choice. With the continuous development of facial-recognition technology, facial recognition payment may become one of the main payment methods in the future, so it is necessary to study the factors that affect the willingness to use.

In addition, perceived ease of use is the degree to which the individual views use of a new innovation to be relatively free from physical or mental effort Moore and Benbasat [23]. That is, new products are highly available and quickly accepted in the marketplace when they provide customers with value that existing products cannot provide in terms of performance or functionality. Lee *et al.* [103] conducted a study on the factors affecting mobile financial services, and found that consumers' cognitive factors (Perceived usefulness and Perceived ease of use), gender, age, and business type had a significant influence on consumers' intent to use.

Many papers mentioned the importance of introducing a face recognition-based payment system from a technical perspective. But no matter how good the technology is, the consumer cannot embrace the new technology unless it is aware of its usefulness for the new technology system. Thus, from a consumer's perspective, this study looks at the factors that affect consumers' willingness to use a face recognition-based payment system. Furthermore, this study wants to confirm whether perceived usefulness mediates the relationship between these factors and the intended use of a face recognition-based payment system.

## II. LITERATURE REVIEW

*Facial-Recognition Payment:*

Since the early 70's, facial-recognition has drawn the attention of researchers in such fields as security, psychology, and image processing Lin [81]. Kelly and James [55] had first studied facial recognition.

Facial-recognition, fingerprint recognition, and iris recognition technology are types of biometric identification technology Bhatia [78]. Facial-recognition systems record face geometric features by focusing on the key features of the face and is a nonintrusive, cheap technology Bhatia [78]. Many authors have studied different aspects of facial-recognition technology. Wójcik *et al.* [62] give the basic elements of the typical face recognition system. Improving the accuracy of verification or identification process has been the focus of many scholars and technicians Becerra-Riera *et al.* [20]. Soft biometrics, although not completely self-identifying, can be properly combined with traditional facial-recognition techniques to improve the accuracy of the verification or recognition process Becerra-Riera*et al.* [20]. As noted by Parmar and Mehta [14] facial-recognition is also useful in human computer interaction, virtual reality, database recovery, multimedia, computer entertainment, and information security.

With the continuous progress of facial-recognition technology and the continuous improvement of facial-recognition payment system, facial-recognition payment is entering people's lives.

Facial-recognition payment bases on the technology of facial recognition. Fei *et al.* [26] present the developmental process of facial-recognition technology. Merchants can collect users' photos and file them in the database, and then use the algorithm to compare users' facial features with photos to achieve facial-recognition payment. In China, for example, commercial operators and government agencies can freely and legally access biometric data through real-time facial-recognition de Cormis [72]. The main characteristics of facial-recognition payment are as follows:

Facial-recognition technology is a nonintrusive, cheap technology Bhatia [78]. Compared to other means of payment, face recognition has certain advantages. Every person's facial features are different. In addition, iris recognition and fingerprint recognition require additional devices, but

facial-recognition, since smart phones already have integrated cameras, requires no additional hardware. Bhatia in 2013 had studied several kinds of biometrics, saying ''Biometrics is a growing technology, which has been widely used in forensics, secured access and prison security'', and comparing the advantages and disadvantages of various identification technologies.

Face recognition is one of the few biometric methods that provide both high accuracy and low intrusiveness Lin [81]. Compared with common payment methods, facial-recognition is a more secure and convenient authentication method than traditional passwords Vazquez-Fernandez and Gonzalez-Jimenez [18]. People used to protect their property through passwords, smart cards, bank cards, and keys, but passwords or PINs are often forgotten, and bank cards or keys are easily lost or stolen. Therefore, people need to seek a new method of protection. The human body is unique and hard to imitate, copy, or lose Parmar and Mehta [14]. Consumers do not need mobile phones or bank cards in the process of shopping. They just need to ''scan their face'' in a shopping place to complete their shopping. A major advantages of biometric payments is simple accessibility and flexibility, eliminating the need for cash or credit cards in areas such as shopping, or public transport, because all consumer demand is mobile Stickland [42].

*Factors Affecting the Use of Facial-Recognition Payment:*

### A. SECURITY

Security means that the system processes personal information and guarantees its confidentiality, integrity, authenticity, and non-replicability to ensure the security and trustworthiness of the transaction Suh and Han [3]. Many researchers have studied the safety of payment systems. Security is one of the most important factors influencing the intent to use of mobile pay; similarly, many scholars regard safety as the main research factor when studying mobile payment (Pham and Ho [92] and use the TAM model to research consumer's intent to use of new technologies. Among them, the character of the new technology itself is one of the main influencing factors. New technologies also pose some associated risks, concerning privacy, personal data, and the transaction itself, further increasing the perceived risk of mobile payment services Shah *et al.* [60]. For this reason, security and risk perception are major concerns in the field of electronic payment systems Ashrafi and Ng [63] and inhibit the intent to use new mobile-payment tools. Thus, the perception of security of the mobile payment system must be controlled Meharia [68] in order for this type of technology to be successfully used Grassie [48].

However, recently, consumers have been aware of some problems in the use of IT technology dealing with the security of identification, personal information, payments, and other technical information. Many scholars have studied privacy protection Ku *et al.* [102]. Security and privacy concerns are also factors that affect the adoption of mobile-payment service Johnson *et al.* [96] Consumers are worried about the leakage of their private information and thus reduce their enthusiasm for use Fogel Nehmad [41]. Consumer concerns about privacy breaches reduce their intent to use. Therefore, it is an important responsibility of merchants to reduce consumers' concerns and improve their privacy protection Ranganathan and Ganapathy [10]. Privacy concerns are an important consideration in successful facial-recognition payment implementation and uptake among consumers Miltgen *et al.* [7]. As with other new technologies, privacy, security, and online identity management are frequently a source of concern to consumers Deane *et al.* [21]; Miltgen *et al.* [7].

### B. VISIBILITY

Visibility is defined as the degree of innovation that the organization can see and the acceptance of new products or services by potential users, if the new products or services have many users Moore and Benbasat [23]. Visibility is also defined as the extent to which individuals use new innovations to serve others Russell *et al.* 2018. Johnson *et al.* [96] pointed out that perceived ease of use, relative advantage, visibility, and perceived security affect the intent to adopt mobile-payment services. In other words, if we can see people using new technologies or services in our communities, that will act as social pressure and positively affect the potential acceptance of new technologies or services. Potential users of new technologies will be affected by the social environment and will be affected if many users are around. The surrounding social environment can put pressure on potential users to accept new technologies or services. Yang and Choi 2001 pointed out that we use the technology acceptance model as the theoretical model of the effect of social influence on the acceptance of information systems. Their results showed that visibility influenced the social effect of the audience, and recognized that the social effect was considered useful. Product visibility is a sub concept of excessive consumption or state consumption, which occurs in a category or position of consumption. Lee and Lee [39] studied the relationship between entertainment, availability and the social effect of mini-home pay by adopting the technology acceptance model. They point out that visibility affects social cognition, which in return affects how consumers perceive the usefulness of the product. Users who use electronic payment methods have found that ''innovation, applicability, universality, reliability and visibility'' of electronic payment methods are important driving factors for the use of payment methods.

Most strikingly, facial-recognition was immediately seen as a powerful means of protecting public Safety de Cormis [72]. What's more, there are also many exciting opportunities for businesses to use facial-recognition to improve the speed and convenience of interacting with customers and provide truly personalized services de Cormis [72]. Similarly, Yum China, which operates KFC and other fast-food brands, has partnered with the

mobile-payment company Alipay to develop the facial-recognition payment verification feature de Cormis [72].

### C. EXPECTED EFFORT

Expected effort is defined as the degree to which people consider it easy to use new information technologies. That is, how intuitive and convenient the information technology interface is, how easy it is to search and use, and how to provide various convenient help features are directly related to expected effort. Many studies that have reported these efforts, have had a significant effect on the interpretation of intent to use Chang *et al.* [30]. Expected effort is critical in the introduction of a new technology. The adoption of a new technology can be constrained and even fail when factors related to ease of use are not taken into account by technology designers Orlikowski [100].

Davis *et al.* [12] suggested that Expected effort has a strong influence on user acceptance of information technology. Expectations about performance, effort, and social acceptance positively influence the intent to use mobile-payment systems. Koenig-Lewis *et al.* [64] use the Unified Technology Acceptance and Use Theory (UTAUT) as a base, to extend the framework by combining variables such as perceived enjoyment, social effect, knowledge, and perceived risk. Expected effort positively influences expectations about performance, and behavioral intention Tiago 2016. De Luna *et al.* [33] used TAM to examine the factors that influenced consumers' acceptance of mobile-payment systems, and found they included perceived compatibility, perceived security, personal innovativeness, and individual mobility. Abrahão *et al.* [79] pointed out in their research that expected effort has a significant and positive relationship with the intent to adopt mobile-payment system.

### D. SOCIAL IMAGE

Social image refers to the extent to which a user thinks his or her state or image is improved in the organizational society to which the user belongs Moore and Benbasat [23]. Social image, actually is an element of a perceived usefulness construct in the technology acceptance model TAM2, which was proposed by Venkatesh and Davis [18].

Jaradat and Faqih [61] studied the main influence factors in his research. The results show that users' adoption and use of mobile payment services can be predicted in terms of what they intent to do, which is significantly affected by the following factors: perceived usefulness, perceived ease of use, subjective norms, image, output quality, self-efficacy, perceived external control and interestingness. In other words, social image affects perceived ease of use and the intent to use information technology in research on the motivation for ongoing use of new technology information services. In addition, the results suggest that social effect may play a role in the intent to use mobile-payment, as is consistent with previous studies suggesting that the social environment influences users' opinions (Liebana-Cabanillas *et al.* 2019). Another study, conducted by Koenig-Lewis (2015) pointed out that social influence, knowledge of technology, and perceived risk had direct influence on consumers' willingness to accept simple payments. In many economic situations, people are concerned not only with their material achievements, but also with maintaining a certain social image. Therefore, the focus of this study is on how to consider the views of other members of society when using these products or services as new technologies.

### E. OPENNESS (OPENNESS TO EXPERIENCE)

Openness was first proposed by Costa and McCrae [69] and defined as curiosity, and an open mind about experiences and values. Those with high openness prefer to experience new imagination and are more receptive to new information Ziegler *et al.* [59]. Openness refers to the tendency of individuals to try new things and experiences. Open individuals may be more willing to change and try new technologies. In our case study, facial-recognition payment technology is a new technology. Consumer characteristics have an important effect on the willingness to accept new technologies and new products, and many scholars have conducted research on various aspects (Lin *et al.* 2013).

Recently, with the development of information technology, new technology or new technology-related services, various attempts have been made to study the role of individual personality in behavioral and usage (Lin *et al.* 2013). Moore and McElroy [52] found that consumer personality traits have a great influence on the willingness to use Facebook. Tlili *et al.* [2] in ''Role of personality in computer based learning'' pointed out that consumer behavior is influenced by personality traits. Openness has a positive effect on perceived usefulness and perceived ease of use Khan *et al.* Mikson. Lee and Lyu [25] studied personal values as determinants of intent to use self-service technology in retailing, using a value-attitude behavior model; they found that personal characteristics have a positive effect on intent to use.

## III. RESEARCH MODEL AND HYPOTHESES

In this paper, construct the following model by choosing the nature of the facial-recognition payment system as independent factors. In this study we selected four major independent factors according to the research thoughts of other scholars on willingness to accept new technology. Perceived usefulness was choose as an intermediate variables, and we chose intent to use as a final dependent variable, because it is seems to be the immediate antecedent of actual behavior Ajzen [31]. In order to study the influence of consumers' own characteristics on behavioral tendencies, this paper had chosen the openness characteristic as the moderating variable. The basis is that consumers' personalities will influence their willingness to accept new products and technologies. Much of the literatures combine a personality model and technology acceptance model to study consumers' intent to accept

new technologies. For example, Moore and McElroy [52] studied the intent to use Facebook by using a Five Factor Model (FFM), and Özbek *et al.* [98] found that some personality traits have significant effects on perceived usefulness and perceived ease of use, and that the latter has significant effects on behavioral intention to use the product.

Fig. 1 depicts our proposed adoption model, which indicates that the characteristics of facial-recognition payment lead to perceived usefulness, which in turn, leads to intent to use. Openness has significant influence in this model.

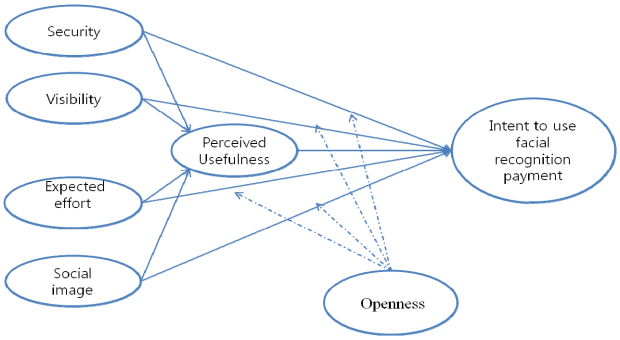


**FIGURE 1.** Research model.

### A. THE RELATIONSHIP BETWEEN SECURITY AND INTENT TO USE FACIAL-RECOGNITION PAYMENT

Bauer [71] was the first to propose perceived risks related to consumer behavior. Security has always been the focus of the payment field. Earlier studies concluded that security concerns inhibit the intent to adopt technologies where monetary information is managed Cheng *et al.* [93]. Jarvenpaa *et al.* [82] believe that, whereas in the early stages of internet application, users' concerns were more about the performance of technologies and how firms have implemented their technologies, and later, security has become a greater concern.

The perceived risk of receiving an information system can have a negative effect on acceptance and behavior. In another study, security features were suggested as features of mobile payment products (Pham and Ho [92]. Some scholars attempted to study the security of mobile payment. For example: perceived technology security analyzes the potential feelings of uncertainty in using a new technology (Cheng et al., 2006).

In addition to the broad definition of "security," there are two main security measures: confidential technology solutions and confidentiality evidence Shah *et al.* [60]. However, with the development of IT technology, consumers are also aware of the problems in the use of IT technology have begun to consider the security of technical information, such as personal information leakage (Ranganathan & Ganapathy, 2002). Therefore, many studies have demonstrated the security of facial-recognition payment systems. For facial-recognition payment, users will be concerned about its security Miltgen *et al.* [7].

*H1: Security Positively Influences Consumer's Intent to Use Facial-Recognition Payment:*

### B. THE RELATIONSHIP BETWEEN VISIBILITY AND INTENT TO USE FACIAL-RECOGNITION PAYMENT

When the technology is relatively new, individuals may not have enough knowledge or information to form their feelings about new technologies (Sukanlaya *et al.* 2014), and consumers can perceive the changes through the actions of others. Some researchers had found that environmental values are a significant predictor of intent to adopt. Chen [49], Arkesteijn and Oerlemans [47] found that knowledge and visibility are important predictors of adoption. Users may have different opinions about visibility and this view is based on product type, consumption, usage conditions, product-related dialogue, and individual variance variables (Bearden and Rose [99]; Chuah *et al.* [88]. The user's perception of visibility may depend on the product, consumption and usage conditions, product-related conversations, and other variables Chuah *et al.* [88]

Especially in today's world, the popularity of clothing, the fashion of accessories and cosmetics, and the uniqueness of new technologies are important aspects of how personal impressions are formed, and emphasize the importance of first impressions Chuah *et al.* [88]. Thus, a person using a brand, product, or possession to reveal a particular personal facet to others needs to ensure that the other individual recognizes such possession Chuah *et al.* [88]. Users who use electronic payment means find that "innovation, integration, popularization, reliability and visibility" of electronic payment means are important driving factors for the use of payment methods. Studies by Sawang *et al.* [87] also supported the positive influence of social norms on mobile service adoption. Individuals may be influenced by social norms, peers, and other important people.

China has a complex society and a humanistic environment. Chinese people pay attention to the goals of the group to which they belong, to adaptation to others, and to the unity of the value of others Bagozzi *et al.* [73].

*H2: Visibility Positively Influences Consumer's Intent to Use Facial-Recognition Payment:*

### C. THE RELATIONSHIP BETWEEN EXPECTED EFFORT AND INTENT TO USE FACIAL-RECOGNITION PAYMENT

Social influence reflects the influence of important people's opinions on individual users Venkatesh *et al.* [94]. Expectations about performance and expected effort were found to be the main determinants of intent to using mobile services in Finland Carlsson *et al.* [5]. Davis *et al.* [12] suggested that expected effort has a strong influence on user acceptance of information technology.

"Expected effort" as a research variable in the ATM and UTAUT models is widely used to study consumer acceptance of new products and technologies (Venkatesh *et al.* [94]; Zhou *et al.* [90]; Im *et al.* [32]. A comparative study of US and Korean consumers' willingness to accept new products

was carried out by Im *et al.* [32]; they found that the U.S. users' decision-making on technology adoption is affected more than Korean users are by how easy the technology is to use. The difficulty level of using new technologies will affect consumers' intent to use them. If consumers feel that there is less difficulty in using new technologies, they will be more likely to use them. In addition, we need to find an important way to improve expectations about performance. Such as a good task technology fit Zhou *et al.* [90]. If users receive services that do not meet their needs, they will consider these services to be less practical and have lower performance expectations Zhou *et al.* [90]. Considering the above discussion, we predicted the following.

*H3: Expected Effort Positively Influences Consumer's Intent to Use Facial-Recognition Payment:*

### D. THE RELATIONSHIP BETWEEN SOCIAL IMAGE AND INTENT TO USE FACIAL-RECOGNITION PAYMENT

Expectations of the social image of new technologies can affect technology acceptance Venkatesh Davis [18]. Social image can show the social status of consumers Moore and Benbasat [23]. Consumers may think that using new technology will improve their performance in social groups and increases its expected usefulness Galan *et al.* [44]. Social influence is similar to the subjective norm of TRA (Venkatesh *et al.* [94] and reflects the effect of environmental factors, such as the opinions of a user's friends, relatives, and superiors on their behavior Lopez-Nicolas *et al.* 2008. A technology will be considered more useful if it helps people to comply with the norms of the group. They may think that using the system will indirectly improve their performance by improving social image Galan *et al.* [44]. In the context of new technology extensions, existing models are extended by adding external variables, such as subjective norms and social images to explain the individual acceptance process Venkatesh and Davis [18]. Considering the above discussion, we predicted the following.

*H4: Social Image Positively Influences Consumer's Intent to Use Facial-Recognition Payment:*

### E. THE RELATIONSHIP BETWEEN PERCEIVED USEFULNESS AND INTENT TO USE FACIAL-RECOGNITION PAYMENT.

Many scholars have studied the relationship between the intent to use and perceived usefulness based on the technology acceptance model. Dissatisfaction with perceived benefits increases the intent to leavePing [75]. The perceived benefits of payment services would increase loyalty through user satisfaction with the target service and thus have a positive effect on the intent to continue use. Service providers need to establish long-term relationships with users and provide them with benefits, including economic, technological and social benefits Kang *et al.* [83]. Providing long-term sustainability benefits can prevent customer loss and maintain the relationship between buyers and sellers Su *et al.* [70].

Most previous studies have pointed out that perceived ease of use has a direct or indirect effect on perceived usefulness and the intent to use information systems Kang *et al.* [54]. Different studies have demonstrated that perceived usefulness has a direct relationship with attitude Hsu and Chiu [53]. Based on previous studies, we also hypothesize that perceived usefulness has a direct effect on intent to use.

*H5: Perceived Usefulness Positively Influences Consumer's Intent to Use Facial-Recognition Payment:*

### F. THE MEDIATION EFFECTS OF PERCEIVED USEFULNESS

TAM explains the motivation of users perceived usefulness, perceived ease of use, and attitude toward use Taherdoost [27], and some other factors known as external variables are put into TAM. Many scholars have conducted research on mobile payment, mobile banking, credit-card payment, and other problems by using the technology acceptance model. Perceived usefulness is the degree to which potential users improve their jobs and work skills by using certain information technologies Davis [12].

There is a lot of literature describing the mediating effects of perceived usefulness. For example, Galan *et al.* [44] studied the media effects of perceived usefulness, where the independent variables are Perceived Social image (PSI), Perceived Self Congruity (PSC), Innovativeness (INO), and Perceived self-efficacy (PSE). There are many studies on the willingness to accept or the intent to use new products and new technologies. The researchers conducted related research by adding other variables based on the ATM and UTAUT models Chuah *et al.* [88]. Scherer *et al.* 2019 used the TAM model to study teachers' willingness to accept new technology, and the mediation effects of perceived usefulness and perceived ease of use are significant.

*H6-1: Perceived Usefulness Will Mediate the Relationship Between Security and Consumer's Intent to Use Facial-Recognition Payment:*

*H6-2: Perceived Usefulness Will Mediate the Relationship Between Visibility and Consumer's Intent to Use Facial-Recognition Payment:*

*H6-3: Perceived Usefulness Will Mediate the Relationship Between Expected Effort and Consumer's Intent to Use Facial-Recognition Payment:*

*H6-4: Perceived Usefulness Will Mediate the Relationship Between Social Image and Consumer's Intent to Use Facial-Recognition Payment:*

### G. MODERATION EFFECT OF OPENNESS

Technology adoption theory suggests that personality may be an important determinant of adoption Rogers [17].

Many studies have proposed the use of personality models to understand individual behavior and characteristics. Each model presents different personality characteristics based on different personality theories Tlili *et al.* [2]. Those who were more open spent more time on Facebook, used it more frequently and posted more posts they created than did those who were less open, but this was negatively correlated

with regret Kelly and James [55]. Research on technology acceptance mainly concentrates on the technological, social, and psychological reasons for accepting the new technology Turan [15]. Özbek *et al.* [98] concluded that personality (Openness to Experience, Conscientiousness, Extraversion, Agreeableness and Neuroticism) had a big effect on technology acceptance. At present, most scholars combine the technology acceptance model and a personality model to study relevant problems. The previous empirical studies have investigated the influence of personality on many aspects, such as income Heineck and Anger [24], life satisfaction (Boyce and Wood [6], employment and social status Viinikainen and Kokko [43], household finance Brown and Taylor [84], energy conservation Shen *et al.* [58]software tool adoption Svendsen *et al.* [22], and new technology (production) adoption Kang *et al.* [54]. He and Veronesi [66] studied the willingness of Chinese residents to accept renewable energy, and found that personality would influence their willingness to accept renewable energy.

Most studies on technology adoption mainly focused on standard demographic, and socioeconomic factors, political factors, and technical factors (e.g., Arkesteijn and Oerlemans [47]; Rebane and Barham [50]. Consumer's characteristics are factors that cannot be ignored. Openness refers to the tendency of individuals to try new things and experiences. Open individuals may be more willing to change and try new technologies He and Veronesi [66]. In this study, facial-recognition payment technology is a new technology. Against the existing literature, this paper will introduce openness as the moderation variable for research.

*H7-1: Openness Positively Moderates the Relationship Between Security and Consumer's Intent to Use Facial-Recognition Payment:*

*H7-2: Openness Positively Moderates the Relationship Between Visibility and Consumer's Intent to Use Facial-Recognition Payment:*

*H7-3: Openness Positively Moderates the Relationship Between Expected Effort and Consumer's Intent to Use Facial-Recognition Payment:*

*H7-4: Openness Positively Moderates the Relationship Between Social Image and Consumer's Intent to Use Facial-Recognition Payment:*

## IV. METHOD

### A. SAMPLE

The final collection quantity of the questionnaire is 318. After elimination and selection, there are 299 valid questionnaires. Among them, 137 male respondents accounted for 45.9 percent of the total. Through the sample, we can find that the young people account for the majority of the respondents, and the number of people aged 21-30 is 148 accounted for 49.7% of the total respondents, and consumers between the ages of 31-40 accounted for 32.4% of the total respondents. More than the average respondent is engaged in business activities, and there are 61 students accounting for19%. The number of people with experience in this survey and the number of people without experience are almost half of the total.

The effective sample number of this study was 299, which met the requirement of the sample number of the proposed structural equation analysis by Hair [38].

### B. MEASURES

All items were measured using a seven-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree). Improving the content validation of the measured items should conceptually indicate the generalizations made. Thus, the scales were selected to ensure content validity and with reference to prior appropriate literature. The items measuring security were adapted from Liao *et al.* [8]and Cheng *et al.* [93]. Items for the openness were taken from (Pornsakulvanich 2017) and He and Veronesi [66]. Visibility was measured using four items adapted from (Yang and Choi 2001). Items for the social image were taken from Agarwal and Prasad [76] and Ha and Janda [28]. Effort expectancy was measured using four items adapted from Davis *et al.* [12] and Chang *et al.* [30] and Shih and Wang 2009. Perceived usefulness was measured using four items adapted from Ravindran and Susarla [53]. Items for the usage intention were taken from Agarwal and Karahanna [77] and Chea and Luo [85].

### C. ANALYSIS PROCEDURE

To test the conceptual model, we conducted structural equation modeling with all of the survey respondents by using Smart-PLS software Ringle *et al.* [9] to examine the hypothesized model. Partial least squares (PLS) structural equation modeling has several advantages over the covariance-based approach to structural equation modeling Alber [89]. Most importantly, PLS makes minimal demands on the sample size, thus making it especially appropriate for testing multi-group structural equation models with relatively small sample sizes Gong *et al.* 2016. In addition, a PLS analysis provides robust estimations for data with extremely non-normal distributional properties. However, influential outliers do influence the data results (Gong *et al.* 2016). Thus, we tried to identify potential outliers by means of box and stem-and-leaf plots using IBM SPSS Statistics. The result indicates no outliers. Moreover, the kurtosis and skewness of the items are not an issue because they are within $-1$ and $+1$, which is an acceptable level Hair *et al.* [45]

### D. RESULTS

#### 1) MEASUREMENT SCALE ASSESSMENT

In order to use the structural model to tests the hypotheses a researcher should exam the indicator loadings. Loadings above 0.70 indicate that the construct explains over 50% of the indicator's variance (Sarstedt *et al.* 2014). Table 1 shows the Constructs and factor loadings. Table1 provides evidence of the significance of the loading or weight of each item within each latent variable. All items of the latent variable should have a significant T-statistic (Sarstedt *et al.* 2014).

**TABLE 1.** T-statistics for convergent validity.

| Construct | Loadings | Standard Deviation | T-Statistics | P Values |
|---|---|---|---|---|
| Expected effort1 | 0.851 | 0.019 | 44.369 | 0.000 |
| Expected effor2 | 0.820 | 0.022 | 36.915 | 0.000 |
| Expected effor3 | 0.842 | 0.019 | 43.397 | 0.000 |
| Expected effor4 | 0.813 | 0.026 | 30.900 | 0.000 |
| Social image1 | 0.766 | 0.035 | 22.102 | 0.000 |
| Social image2 | 0.821 | 0.023 | 36.068 | 0.000 |
| Social image3 | 0.850 | 0.019 | 44.542 | 0.000 |
| Social image4 | 0.846 | 0.018 | 48.330 | 0.000 |
| Perceived usefulness1 | 0.874 | 0.014 | 62.179 | 0.000 |
| Perceived usefulness2 | 0.781 | 0.026 | 30.566 | 0.000 |
| Perceived usefulness3 | 0.815 | 0.025 | 33.201 | 0.000 |
| Security1 | 0.855 | 0.020 | 43.635 | 0.000 |
| Security2 | 0.813 | 0.025 | 32.673 | 0.000 |
| Security3 | 0.879 | 0.013 | 65.927 | 0.000 |
| Security4 | 0.787 | 0.028 | 28.027 | 0.000 |
| Intent to use1 | 0.874 | 0.015 | 59.945 | 0.000 |
| Intent to use 2 | 0.846 | 0.019 | 44.089 | 0.000 |
| Intent to use 3 | 0.891 | 0.013 | 69.709 | 0.000 |
| Intent to use 4 | 0.859 | 0.018 | 47.882 | 0.000 |
| Visibility1 | 0.917 | 0.011 | 87.347 | 0.000 |
| Visibility2 | 0.902 | 0.013 | 67.038 | 0.000 |
| Visibility3 | 0.899 | 0.013 | 70.366 | 0.000 |
| Visibility4 | 0.910 | 0.012 | 77.091 | 0.000 |

The chi-square value and the ratio of chi-square to degrees of freedom are acceptable (2.3). At the same time the value of SRMR = 0.056 smaller than 0.08 which proposed by Hu and Bentler 1999. The value of d-G = 0.346 smaller than 95% bootstrap quantile (HI95 = 0.359) meet the judgment criteria proposed by Henseler *et al.* [46]2016. The result of Multicollinearity test also acceptable as the Variance Inflation Factor (VIF) values are ranged from 1.323 to 3.312. Determining significance is an important first step and essential when calculating the correct path estimates (Chin *et al.* 2003) and here set the significance level p = 0.05. The average variance extracted (AVE) and the composite reliabilities for all constructs were estimated to confirm the internal consistency of the constructs. Composite reliabilities are greater than 0.70, indicating that the measures are reliable Hair *et al.* [37]. All AVEs exceed the criteria of 0.50, which confirms internal consistency Bagozzi and Yi [74].

Table 1 also gives the out loadings about all latent variables. All loadings are bigger than 0.7 which provides evidence of indicators' reliability Kang *et al.* [54].

In table 2 we see that all AVE values are greater than 0.5. It can be seen from the table that the value of Cronbach's Alpha of all items are bigger than 0.70 and the internal consistency reliability are acceptable. Most scholars believe

**TABLE 2.** Construct reliability and validity.

| | Cronbach's Alpha | rho_A | Composite Reliability | AVE |
|---|---|---|---|---|
| Expected effort | 0.820 | 0.826 | 0.881 | 0.649 |
| Perceived usefulness | 0.713 | 0.718 | 0.840 | 0.636 |
| Security | 0.827 | 0.839 | 0.885 | 0.659 |
| Social image | 0.825 | 0.827 | 0.884 | 0.656 |
| Intent to use | 0.842 | 0.849 | 0.894 | 0.678 |
| Visibility | 0.922 | 0.924 | 0.944 | 0.809 |

that Cronbach's Alpha greater than 0.7 is an acceptable standard, but the standard adopted in the practical problem study is 0.60. This study used the criteria of Cronbach's alpha for establishing the internal consistency reliability: Excellent ($\alpha > 0.9$), Good ($0.7 < \alpha < 0.9$), Acceptable ($0.6 < \alpha < 0.7$), Poor ($0.5 < \alpha < 0.6$), Unacceptable ($\alpha < 0.5$) (Kline 2000; George and Mallery 2003). Table 1 was shown in detail.

### 2) DISCRIMINANT VALIDITY

There are two methods to test discrimination validity. One is the Fornell-Larcker criterion (proposed by Fornell and Larcker 1981) and the HTMT Henseler *et al.* [46]. Discriminant validity is achieved if the square root of the AVE for each construct exceeds the correlations of the construct with other constructs Anderson and Gerbing [36]. If the diagonal values are bigger than any other correlation, it means adequate discrimination validity is established (Sarstedt *et al.* 2014). In order to clearly discriminate between two factors, the HTMT must be smaller than 0.9 Henseler *et al.* [46].

Table 3 and table 4 shows details below: all diagonal values are greater than other correlation and HTMT values are smaller than 0.9 provides evidence of the discrimination validity.

**TABLE 3.** Discrimination validity through AVE.

| | Expected effort | Perceived usefulness | Security | Social image | Intent to use | Visibility |
|---|---|---|---|---|---|---|
| Expected effort | **0.805** | | | | | |
| Perceived usefulness | 0.675 | **0.798** | | | | |
| Security | 0.501 | 0.507 | **0.812** | | | |
| Social image | 0.503 | 0.595 | 0.544 | **0.810** | | |
| Intent to use | 0.653 | 0.689 | 0.576 | 0.631 | **0.823** | |
| Visibility | 0.103 | 0.248 | 0.367 | 0.459 | 0.382 | **0.900** |

### 3) COMMON METHOD BIAS

To verify the existence of common method bias, Harman's single factor test was performed. Many prior studies have indicated that measuring variables in the study model in

**TABLE 4. Discrimination validity through HTMT.**

| | Expected effort | Perceived usefulness | security | Social image | Intent to use | visibility |
|---|---|---|---|---|---|---|
| Expected effort | | | | | | |
| Perceived usefulness | 0.879 | | | | | |
| Security | 0.609 | 0.656 | | | | |
| Social image | 0.607 | 0.776 | 0.656 | | | |
| Intent to use | 0.718 | 0.881 | 0.691 | 0.754 | | |
| Visibility | 0.119 | 0.305 | 0.418 | 0.525 | 0.433 | |

**TABLE 5. Total variance explainment.**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 9.366 | 40.723 | 40.723 | 9.366 | 40.723 | 40.723 |
| 2 | 2.605 | 11.327 | 52.048 | 2.605 | 11.327 | 57.819 |
| 3 | 1.327 | 5.771 | 57.819 | 1.327 | 5.771 | 57.819 |
| 4 | 1.043 | 4.534 | 62.353 | 1.043 | 4.534 | 62.353 |
| 5 | 0.833 | 3.620 | 65.937 | | | |
| 6 | 0.795 | 3.457 | 69.430 | | | |

**TABLE 6. Values of $f^2$.**

| | F2 value |
|---|---|
| Perceived usefulness—intent to use | 0.094 |
| Social image—perceived usefulness | 0.099 |
| Social image—intent to use | 0.039 |
| Expected effort—perceived usefulness | 3.201 |
| Expected effort—intent to use | 0.111 |
| Security—perceived usefulness | 0.014 |
| Security—intent to use | 0.031 |
| Visibility—perceived usefulness | 0.001 |
| Visibility—intent to use | 0.046 |

**TABLE 7. Diarect effect results.**

| H hypotheses | M | SE | T | P | Adoption |
|---|---|---|---|---|---|
| H1 | 0.140 | 0.051 | 2.742 | 0.006 | Supported |
| H2 | 0.152 | 0.042 | 3.600 | 0.000 | Supported |
| H3 | 0.292 | 0.068 | 4.281 | 0.000 | Supported |
| H4 | 0.172 | 0.080 | 3.004 | 0.002 | Supported |
| H5 | 0.278 | 0.057 | 4.049 | 0.000 | Supported |

the same way results in errors that significantly threaten the validity of the study results Podsakoff *et al.* [67]. Podsakoff *et al.* [67] stated that the same method bias exists in relation to each variable that occurs in measuring more than one variable. Therefore, they argued that measuring more than one variable in the same way would not only result in higher measured correlation than actual correlation, but also distort the measured value. Harman's single factor test, which is the most commonly used method for diagnosing the same method, suggests essential use in many prior studies Podsakoff *et al.* [67]. As a result, the table produces four factors with a unique value of 1 or more and the descriptive power of the first factor is only 40.723% of the total variance, and therefore cannot be considered absolute Roxas *et al.* 2012. Therefore, the data collected for this study can be determined that the problems caused by the common method bias are not serious.

### 4) STRUCTURAL MODEL AND HYPOTHESIS TESTS

The overall fit indices for the structural model indicate acceptable good model fit. The $R^2$ is a measure of the variance explained in each of the endogenous constructs and is thus a measure of the model's predictive accuracy (in terms of in-sample prediction). The percentages of explained variance ($R^2$) for perceived usefulness is 0.551 and for usage intention is 0.629 suggesting that the structural model has predictive relevance Hair *et al.* [45]; Gong *et al.* 2016. Another means to assess the model's predictive relevance is the Q2 value which also called blindfolding. According to Hair *et al.* [45] Q2 values larger than zero for a particular endogenous construct indicate that the path model's predictive accuracy is acceptable. Here the values of Q2 are as: effort expectation (0.403); perceived usefulness (0.288); security (0.419); social image (0.414); usage intention (0.447); visibility (0.623).The details are showed in table 5 and table 6.

Study hypothesis test can be by standardized regression weight. Standard is used to describe the accuracy or accuracy of the original data. The adoption of the hypothesis is based on a criterion of C.R. (Critical Ratio). If T $\geq$ 1.96 and the significance level (P-Value) is smaller than 0.05 we can accept the hypothesis. And the results about direct effect are as follow in Table 7.

H1, which suggests that security has a positive influence on consumers' intent to use facial-recognition payment, was supported ($\beta$ = 0.140, p = 0.006<0.05). At the same time, It showed that visibility has a direct impact on consumers' intent to use facial-recognition payment ($\beta$ = 0.152, p = 0.000<0.05), H2 was supported. Expected effort also has a direct positive impact on consumers' intent to use facial-recognition payment and H3 was supported too ($\beta$ = 0.292, p = 0.000<0.05). There is a direct relation between social image and intent to use facial-recognition payment, and H4 is supported too ($\beta$ = 0.172, p = 0.002<0.05). The effect of perceived usefulness is also very obvious, which is consistent with the research results of other scholars and H5 is supported.

### 5) MEDIATION TEST

We tested the mediation research hypotheses following the guideline suggested by Zhao *et al.* [101]. According to Zhao *et al.* [101], the complete, partial and unmediated classification of the baron and Kenny classification is misleading because the significant overall impact of independent variables on dependent variables is not mediated.

Instead, they argue, the mediation hypothesis can be supported if the indirect effects are significant. Therefore, we are concerned with the computational significance of indirect effects. In this study, we computed the t-values from 1,000 bootstrapping runs. Bootstrapping is a nonparametric resampling procedure that involves repeatedly sampling from the data set and estimating the indirect effect in each resampled data set (Gong *et al.* 2016). By repeating the process many times, the approximation of the sampling distribution of indirect effects is established and used to calculate the t value of the intermediate hypothesis. Then, the standard deviation was calculated and finally t-value of the indirect effect can be computed by dividing the indirect effect with the standard deviation Hair *et al.* [45]; Preacher and Hayes [51]. Table 8 shows the results of mediation effect of perceived usefulness.

**TABLE 8. Mediation test results.**

| Hypotheses | M | SE | T | P | Adoption |
|---|---|---|---|---|---|
| H6-1 | 0.028 | 0.029 | 1.445 | 0.149 | Unsupported |
| H6-2 | 0.008 | 0.008 | 0.647 | 0.518 | Unsupported |
| H6-3 | 0.132 | 0.133 | 3.684 | 0.000 | Supported |
| H6-4 | 0.008 | 0.080 | 3.154 | 0.002 | Supported |

*H6-3,* which states that perceived usefulness mediates the relationship between expected effort and consumer's intent to use facial-recognition payment. This finding supports this hypothesis, because the indirect effect via the perceived usefulness in facial-recognition payment system ($\beta = 0.132$, p = 0.000).*H6-1*($\beta$= *0.028, p = 0.149)* and *H6-2*($\beta$= *0.017, p = 0.518)* the results showed that the security and visibility of facial-recognition payment just had direct effect on peoples' usage intention and perceived usefulness has no mediation effect. Perceived usefulness also has no mediation effect on the relationship between social image and usage intention, so *H6-4*($\beta$= *0.08, p = 0.005)* is supported too.

### 6) MODERATION TEST

In this study, we computed the t-values from 1,000 bootstrapping runs. Bootstrapping is a nonparametric resampling procedure that involves repeatedly sampling from the data set and estimating the indirect effect in each resampled data set (Gong *et al.* 2016). Table 9 posited the moderation test details.

H7-1 posits that openness positively moderates the relationship between security and usage intention.H7-1 is supported ($\beta = 0.133$, p = 0.002). H7-2 states that openness does not positively moderate the relationship between visibility and usage intention as $\beta$ = -0.040, p = 0.418. So H7-2 is unsupported. H7-3 posits that openness positively moderate the relationship between effort expectation and usage intention. H7-3 is supported ($\beta = 0.118$, p = 0.039). Finally the hypotheses H7-4 showed that openness has no significant role on the relationship between social image and usage intention. Hence, H7-4 is unsupported.

**TABLE 9. Moderation test results.**

| Hypotheses | M | SE | *T* | P | Adoption |
|---|---|---|---|---|---|
| H7-1 | 0.133 | 0.042 | 3.137 | 0.002 | Supported |
| H7-2 | -0.040 | 0.049 | 0.809 | 0.418 | Unsupported |
| H7-3 | 0.118 | 0.057 | 2.072 | 0.039 | Supported |
| H7-4 | 0.042 | 0.052 | 0.807 | 0.420 | Unsupported |

**TABLE 10. Questionnaire.**

| Constructs | Items | Source |
|---|---|---|
| **Security** | The facial recognition payment platform provides good firewall technology to prevent unauthorized intrusion | Tan and Teo (2000) ; Liao and Chen (2002). Cheng et al., (2006) Shao et al. (2019) |
| | The facial recognition payment system establishes a sound system for structural assurance | |
| | The facial recognition payment system guarantees the protection of my personal account in real time dynamically | |
| | Overall mobile payment is a safe place to send sensitive information | |
| **Social image** | Facial recognition payment would help me to feel acceptable | Agarwal and Prasad (1997) Lu et al.(2011) Ha et al., (2017). |
| | Facial recognition payment would improve the way I am perceived | |
| | Facial recognition payment would make a good impression on other people | |
| | Facial recognition payment services would give its owner social approval | |
| **Perceived usefulness** | The use of facial recognition payment would help me to pay faster | Ravindran (2015) Cho et al. (2017) Lee et al., (2018). |
| | The use of facial recognition payment would facilitate the delivery | |
| | The use of facial recognition payment would help me to save money and time | |
| | Generally, the use of facial recognition payment would be useful in performing in daily life | |
| **Usage intention** | I intend to continue using facial recognition payment system in the future | Agarwal and Karahanna (2000) Huanget al., (2016) Chea and Luo (2008). |
| | I will always try to use facial recognition payment system in my daily life | |
| | I plan to continue using facial recognition payment system frequently | |
| | I will use the facial recognition payment more preferentially than other methods. | |
| **Visibility** | I saw people around me using facial recognition payment system. | Yang and Choi (2001) Liu et al., (2018) Moore and Benbasat (1991) |
| | I saw people around me using facial recognition payment system frequently. | |
| | There are a lot of auxiliary devices for facial recognition payment around me. | |
| | My relatives and friends use facial recognition payment system frequently. | |
| **Openness** | I like creative work. | Chen et al., (2011). Pornsakulvanich,(2017) He et al.,(2017) |
| | I am a curious person. | |
| | I am intelligent. | |
| | I am rich in imagination. | |
| **Expected effort** | Skillfully using facial recognition payment is easy for me. | Davis (1989) Chang and Wuang, (2007) Wang and Shih (2007). |
| | I find that using facial recognition payment is easy. | |
| | Learning how to use facial recognition payment is easy for me. | |
| | My interaction with facial recognition payment is clear and understandable. | |

## V. DISCUSSION

Despite increasing recognition of the effect that different factors may exert on acceptance of facial-recognition payment systems, this influence has been under-researched until now. There is a lack of explanatory models and empirical and theoretical construction studies in the field of facial-recognition payment. It is very important to fill this gap in theory and practice.

This research contributes to research on acceptance of specific biometric identification systems (facial-recognition payment) as follows:

(1) Consumers are still concerned about the security of facial-recognition payments. The level of security has a direct effect on consumer intent to use. Information security, privacy protection, and property security are all contents that consumer care about Miltgen *et al.* [7]. Although consumers' positive or innovative attitude towards high-tech products has a significant positive effect on alternative payment preference, consumers remain conservative about new technologies because of the need for privacy (Kim *et al.* [57]. Wright [19] pointed out that biometric technology requires the collection of large amounts of personal data, which increases consumers' concerns about the leakage of private information. Facial-recognition payment being a new technology, how to eliminate consumers' worries about information disclosure is a relatively important issue.

(2) Consumers' consumption will be affected by the surrounding environment. In other words, if consumers can see people using new technologies or services in their communities, that will act as social pressure and positively affect the potential acceptance of new technologies or services Chuah *et al.* [88]. The visibility of technologies or products affects social cognition, which in turn affects how consumers perceive the usefulness of the products or the technologies Lee and Lee [39]. Consumers get a certain amount of pressure and try out new products or services when they find themselves surrounded by people using the new technology or service. Results indicate that visibility can directly affect consumers' use of facial-recognition payment.

(3) Many studies that have reported these efforts have had a significant effect on the interpretation of intent to use (Chang *et al.* [30]; Shih and Wang 2009). Previous studies have also revealed the effects of performance expectation, expected effort, social influence, and promotion on what uses intent to do Zhou *et al.* [90]. Much research has found the significant effect of perceived cost on adoption of new products or technology, such as mobile pay Hong *et al.* [89]. The effort expected has a connection with the consumer's self-efficacy, when the consumer realizes that his effort will be rewarded with positive results, the consumer will be encouraged. The expected judgment of consumers on facial-recognition payments will directly affect how they use the payment.

(4) Social image directly affects consumers' intent to use facial-recognition payment. Consumers' intent to use new technologies or services is often influenced by the impression they leave on others around them and the evaluation they receive from people around them. A technology will be considered more useful because it helps people conform to the norms of a group. Consumers will think that using a system will indirectly improve their performance because of improving their image Galan *et al.* [44] 2013). The results showed that this kind of impression given to consumers by the outside world will affect their intent to use through perceived usefulness which is similar to Jaradat et al. in 2014. One can assume that appreciation and praise from the outside will give consumers a sense of confidence and satisfaction, which will increase the perceived benefits (perceived usefulness) and thus affect their intent to use.

(5) The mediation effect of perceived usefulness is clearly shown. The application of facial-recognition technology payment is a new product. Consumers may need to adapt it during use. If the related auxiliary facilities are not sound, the consumer may find the use to be cumbersome and time consuming. Therefore, consumer attitudes may be affected by potential value (perceived usefulness). Jaradat and Faqih pointed out that user adoption and use of mobile payment services can be predicted from what they intent to do, which is significantly affected by subjective norms, image, and output quality. Social image has a direct influence on intent to use and also can affect it through mediating variables (perceived usefulness). These findings further validate the TAM model.

(6) It shows that personality has a profound effect on the behavior of consumers. Open individuals are likely to be more willing to change and try new technologies He and Veronesi [66]. Personality is an important factor affecting the adoption of new technologies Rogers [17]. Openness reflects the difference in attitudes of individuals towards new experiences. Open individuals are creative, insightful, and imaginative. Individuals who have more openness may favor the experience of using a new technology (He and Veronesi [66]. Personality plays a significant role in the acceptance of new products and technologies He and Veronesi [66]. Many prior studies have studied openness as an independent variable Kelly and James [55]; Tlili *et al.* [2]. Openness plays a significant role between security and intent to use and in the relationship between expected effort and intent to use.

## VI. IMPLICATIONS

This study serves as an early attempt to empirically test the determinants of acceptance of facial-recognition payment systems.

First, it contributes to customer marketing research and consumer behavior marketing by empirically testing the important role of perceived usefulness in adoption of facial-recognition payment. There are few empirical studies, and other studies mainly focus on work theory or system technology. This article has some theoretical guiding significance for future research by proposing a theoretical framework that tests the influence of various antecedent factors of behavioral intent to accept facial-recognition payment systems.

Second, the study recognizes the importance of expected effort, security of facial-recognition payment, visibility, and social image on individual willingness to adopt a new technology. Based on this model, researchers can combine other models for further study. This paper provides a powerful basis for research on adoption of facial-recognition payment.

Third, personality (openness) is a moderating variable in this paper, which is relatively rare. Most studies combine personality as an independent variable with the technology acceptance model. Moore and McElroy [52] and Tlili *et al.* [2] studied the effects of openness on the

acceptance of new technologies combined with different models. This paper takes openness as a moderating variable. The characteristics of consumers are not only openness (Venkatesh and Bala [95], but do other characteristics also affect the behavior of consumers? Therefore, similar studies can be continued.

For practice, the results of this study provide several interesting insights into consumer willingness to adopt facial-recognition payment services.

First, research shows that emerging technologies must be able to demonstrate the practical benefits of sophisticated and deep-rooted traditional technologies. Therefore, the provider must be able to clearly express these benefits to the consumer. For example, when a vendor combines facial-recognition payment service with a loyalty reward program, the value of leveraging the new service is increased. Therefore, linking facial-recognition payment services to peripheral programs to increase value can be an incentive to consumers. Compared to other more mature payment methods, people's attitude toward facial recognition payment is rather vague.

Second, this study shows that security and privacy remain important issues for consumers. As the visibility of security breaches increases, consumers are increasingly more aware of the threats associated with technology-based transactions, consistent with the views of Slade, Williams and Dwivedi 2013. Johnson *et al.* [96] recommends that everyone play a role in the mobile payment ecosystem, because security concerns are ubiquitous. As the visibility of security breaches increases, consumers are increasingly aware of threats associated with technology-based transactions Johnson *et al.* [96]. The promotion of new technology needs theoretical guidance Miltgen *et al.* [7]. They must be aware that even if they promote a system that can execute secure transactions, consumers are increasingly concerned about the risks involved. Suppliers must do everything possible to increase consumer confidence in the security of the system. The results of this study provide useful and valuable information for service providers, governments, and enterprises and drive them to offer users this security in their everyday applications.

All in all, this article is a more comprehensive study of facial-recognition payment service than has been most of the research focused on the security and working principle of the facial-recognition payment system. There are few studies on whether consumers are willing to use or influence consumers' willingness to use it. Therefore, this paper has high value for both theory and practical application..

## VII. LIMITATIONS AND FUTURE RESEARCH

The limitations of this study are as follows:

First, we can see from the research subjects that people with and without experience are close to each other, which reflects that the popularity of facial-recognition payment is not too high, so it may be unfamiliar to some consumers. There may be some ambiguity when answering the questionnaire. In order to further understand consumers' willingness to accept facial-recognition payment, further in-depth studies are needed in future studies. Experience can also be added to the model as a variable, which may be a good research direction.

Second, Guo and Bouwman [40] studied interactions between consumers and merchants. We believe that for the emergence and acceptance of new technologies, consumers need to interact with merchants to increase their trust and induce their intent to use through trust. Therefore, in future studies, we need to consider the interaction between consumers and merchants and the interaction between social communities. It may be an interesting research direction to understand the willingness to accept new products by studying the interaction and influence between social groups.

Third, at present, most research on facial-recognition payment has mainly focused on the security and working principle of the payment system. Therefore, this paper draws lessons from many papers related to the intent to accept simple payment or mobile payment in the writing process. More factors influencing facial-recognition payment systems need to be explored and studied. Therefore, this study needs to continue to supplement relevant knowledge in order to enrich the future research process.

Fourth, although consumers believe that facial-recognition payment is a relatively safe method of payment, they are worried about the disclosure of personal privacy. Therefore, the achievements in the protection of personal privacy need to be further studied. This paper does not consider the efect of social factors, which is a deficiency.

Finally, since facial-recognition payment is as mature as other simple payment methods, many consumers still use other payment methods and hold a wait-and-see attitude towards facial-recognition payment. As a result, facial-recognition payment is only a trial (nonmainstream) product at present, so consumers' enthusiasm and feelings about using facial-recognition payment are not too high. Therefore, in future studies, consumers should be divided into two groups (with and without experience) for comparative study.

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