
Explaining intention to use mobile banking: integrating perceived risk and trust into the technology acceptance model

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Abstract: This study explores customers' mobile banking acceptance behaviour using the technology acceptance model (TAM) integrated with the variables of perceived risk and trust. Research employed a sample of 403 customers of one of the largest joint stock commercial banks in Vietnam. Results show that the integrated model explains more than 76% of the variability of intention to use mobile banking. The results also show that perceived risk is negatively related to trust, perceived usefulness and intention to use mobile banking. Trust is positively associated with perceived ease of use, perceived usefulness and intention to use mobile banking. Perceived ease of use is positively associated with perceived usefulness and intention to use mobile banking. Perceived usefulness is positively related to intention to use mobile banking. Implications are drawn to enhance intention to use mobile banking.

Keywords: mobile banking; perceived risk; trust; intention to use; technology acceptance model; TAM; Vietnam.

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1 Introduction

Prominent developments in wireless internet technology and mobile devices are dramatically changing the way in which service companies interact with customers (Kalinic and Marinkovic, 2016). Banks are no exception (Liebana-Cabanillas and

Alonso-Dos-Santos, 2017; Long and Vy, 2016). Mobile banking is one of e-commerce's most popular services and is expected to continue to achieve high growth rates in the future (Hanafizadeh et al., 2014). Consequently, banks are now in a fierce competition over providing mobile banking services to their customers (Changchit et al., 2018).

Mobile banking not only benefits banks but also customers (Jun and Palacios, 2016; Pham et al., 2019c). For banks, mobile banking helps cut investment costs in physical bank branches, increase market share and improve profitability (Chong et al., 2012). For customers, making banking transactions anytime and anywhere is one of the most obvious benefits (Hanafizadeh et al., 2014).

In the mobile banking environment, a mobile device connected to the wireless internet, allows customers to conveniently conduct banking transactions anytime and anywhere (Changchit et al., 2017). Internet banking activities include balance inquiries, transfers, bill payments and investments in financial assets, all of which can be performed without being limited by space and time (Marinkovic and Kalinic, 2017).

As the prices of popular mobile devices such as smartphones, tablets or personal digital assistants (PDA) have come down, these devices have become more popular not only in developed countries but also in developing countries (Park and Tussyadiah, 2017). With sharp increases in mobile device users, the number of mobile banking users is expected to increase dramatically (Marinkovic and Kalinic, 2017). However, these expectations have not proven out to the degree anticipated. It now appears there are a number of factors that influence the adoption of mobile banking (Afshan and Sharif, 2016; Yadav et al., 2016; Zhou, 2012) and these factors might be different from the factors that influence the adoption of online banking (Cabanillas and Santos, 2017).

A thorough review of the literature indicates that there are many theories, models and frameworks used to explain mobile banking adoption (Changchit et al., 2017). One of the most popular theories is the technology acceptance model (TAM). It is one of the most used models to predict customers' new technology adoption behaviour (Aboelmaged and Gebba, 2013). This model is also commonly used to explain customers' mobile banking acceptance behaviour (Chitungo and Munongo, 2013). TAM focusses on two fundamental factors affecting customers' mobile banking adoption behaviour, perceived ease of use and perceived usefulness (Safeena et al., 2012).

Although, TAM is one of the most commonly used models for studying aspects of online banking use, this model has also been criticised for its limited scope. Specifically, it ignores other factors unique to the mobile banking environment that may affect intention to use mobile banking (Ramdhony and Munien, 2013). A second limitation in the previous TAM studies was that most of these studies were conducted in developed countries. Very few were done in developing countries. For example, there has been almost no systematic, comprehensive study conducted in Vietnam, a newly emerging country with an economic growth rate among the highest in the world. Vietnam has about 100 million inhabitants and has advanced internet infrastructure and wireless technology (Dieu, 2018). Vietnam's number of smartphone users is increasing and its commercial banking system is increasingly integrating into the region and the world (Phan, 2016).

Further, Vietnam is a member of ASEAN and is situated in one the world's most dynamic economic regions (Pham et al., 2013, 2018a, 2018b, 2019a, 2019b; Pham and Doan, 2014). Given these circumstances, Vietnam presents a prime population for study regarding the use of mobile banking.

A third drawback regarding TAM research on mobile banking adoption is that, while the role of perceived risk has been confirmed, the model looks at perceived risk as a

single-factor construct. However, other studies on mobile banking adoption such as Lee et al. (2007) and Luo et al. (2010) see perceived risk as a multi-factor construct. Lee et al.'s (2007) research was conducted in South Korea and Luo et al.'s (2010) was conducted in the USA. South Korea and the USA are both developed countries and their mobile banking environments may be different from Vietnam's mobile banking environment.

This study aims to fill the research gap reflecting these limitations of past TAM research. In previous research, the concepts of perceived risk and trust have been confirmed to play an important role in predicting customer behaviour in the online banking environment (Lee et al., 2007). Specifically, this study integrates two other variables, perceived risk and trust, into the TAM model to create an integrated model with more predictive power regarding intention to use mobile banking. Since highly convenient mobile banking is an increasingly popular variation of online banking (Luo et al., 2010; Zhou, 2012), perceived risk and trust appear reasonable targets for study because they may be expected to relate to intention to use not simply online banking, but mobile banking as well (Pavlou, 2003).

To deal with another TAM criticism, the concept of perceived risk will be explored as a multi-factor construct with differing component risk elements. In addition, this study focusses on the relatively understudied developing country of Vietnam. In summary, this study seeks to significantly contribute to the literature by integrating perceived risk and trust into the TAM and examining this integrated model's predictive power for intention to use mobile banking in Vietnam, a research setting ignored by the previous studies. The objectives of this study include:

- 1 To explore component risk factors that may constitute perceived risk.
- 2 To examine whether integrating perceived risk and trust into the TAM increases predictive power for intention to use mobile banking.
- 3 To compare the results of this study with that of prior studies on mobile banking adoption in developed countries to see if and how they may differ.
- 4 To provide recommendations for banks to increase customers' intention to use mobile banking.

This paper is structured as follows. The research model and hypotheses are first developed (Section 2), then, the research method is described (Section 3). Research results are then presented in Section 4, followed by a discussion of the research results along with implications (Section 5). Conclusions, limitations and future research directions are presented in Section 6.

2 Theoretical framework

2.1 Mobile banking

Advances in information and communication technology have been revolutionising interactions between banks and customers (Gao and Waechter, 2017). As with the research of Luo et al. (2010), this study argues that mobile banking can be defined as a banking application that allows customers to complete banking transactions and

interactions such as accessing bank accounts, balance inquiries, transfers, bill payments, or securities trading via a mobile device such as a smartphone, tablet or PDA, connected to the wireless internet. In either developed or developing countries, in the mobile banking environment customers can conduct transactions and interactions through:

- 1 mobile banking applications loaded into a smartphone
- 2 mobile browsers which can be used with any mobile device with a web browser
- 3 mobile banking applications loaded into a tablet
- 4 short messaging services system providing notifications about account information (Yuan et al., 2014).

If online banking is an evolutionary form of traditional banking, then, mobile banking is an evolutionary form of online banking (Jun and Palacios, 2016). Traditional banking is characterised by interactions between customers and the bank employees at the bank's physical branch (Long and Vy, 2016). Online banking is characterised by interactions between customers and the bank's website through a desktop computer connected to the internet (Jun and Cai, 2001). Mobile banking is characterised by interactions between customers and the bank through a mobile device connected to the wireless internet (Oliveira et al., 2016). Banking transactions in the mobile banking environment are not restricted by space and time (Marinkovic and Kalinic, 2017).

However, given the many terms used to refer to mobile banking such as m-banking, non-branch banking, mobile payment, mobile transfer, mobile finance, pocket banking, or mobile financial investment (Shaikh and Karjaluo, 2015), there might be some confusion between online banking and mobile banking. In the online banking environment, interactions between customers and the bank's website are made through a desktop connected to the internet (Jun and Cai, 2001). Similarly, interactions between customers and the bank's website via a laptop connected to the internet should not be classified in mobile banking since a laptop's interface is similar to a desktop's interface. The difference between online banking and mobile banking is that transactions in the mobile banking environment are accomplished through a wireless internet-connected mobile device (Yuan et al., 2014).

Overall, mobile banking is one of mobile commerce's most popular services and is an evolutionary manifestation of online banking (Alfahl et al., 2017). With technological advancements, especially mobile technology and wireless internet, mobile banking has its potential to grow and become popular not only in developed but also in developing countries (Chong et al., 2012; Malaquias and Hwang, 2016).

2.2 Technology acceptance model

To date, there have been a number of studies on factors affecting mobile banking adoption. These studies use different models to predict mobile banking adoption, including the TAM, innovation diffusion theory (IDT), theory of planned behaviour (TPB) and unified theory of acceptance and use of technology (UTAUT). Some studies have used combinations of the above models or theories, such as the combination of TAM and TPB (Aboelmaged and Gebba, 2013), TAM and IDT (Ramdhony and Munien, 2013), UTAUT and task-technology fit model (Zhou et al., 2010), or UTAUT, IDT and the ubiquitous computing framework (Saeed, 2011). These studies have spelled-out

various factors affecting mobile banking adoption, including perceived ease of use, perceived usefulness, trust, social influence, perceived risk, self-efficacy, compatibility, facilitating conditions, cost, credibility, culture, demographic factors and structural insurance. For a full picture of the factors affecting mobile banking adoption, refer to Changchit et al. (2017).

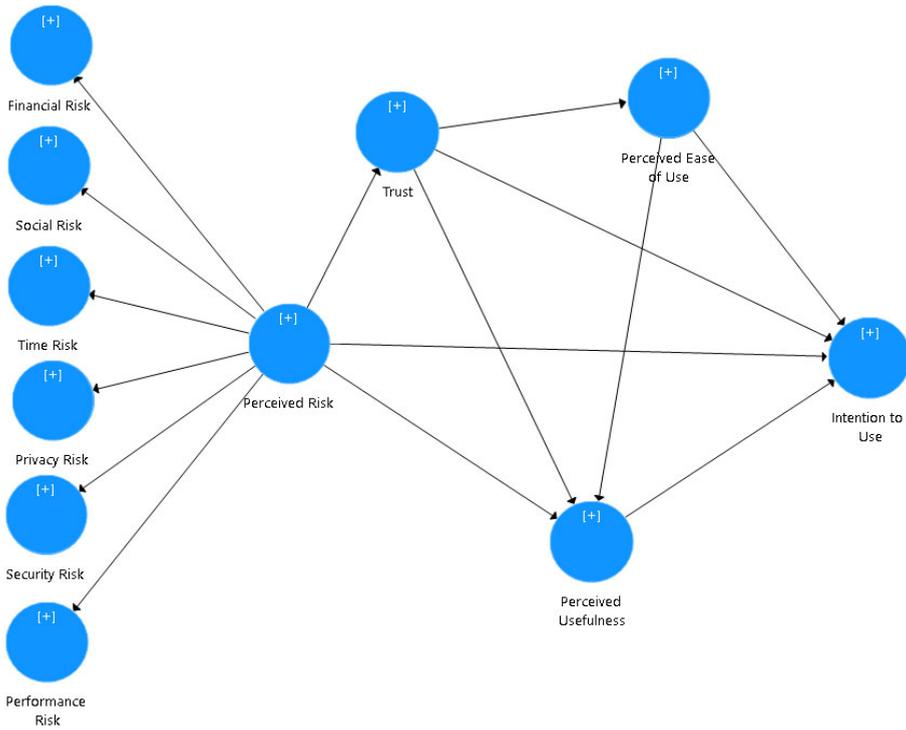
Although there are many models and theories used in mobile banking adoption studies, TAM can be considered the most used model. Shaikh and Karjaluo (2015) conducted a review of the literature and pointed out that 42% of research on mobile banking adoption used TAM as a theoretical foundation. Two important factors in TAM that influence mobile banking adoption are perceived ease of use and perceived usefulness. Empirical studies have found evidence that perceived ease of use has a positive relationship with perceived usefulness and intention to use mobile banking and perceived usefulness is positively associated with intention to use mobile banking (Gu et al., 2009). Consistent with previous studies, this study also uses TAM as a research foundation to examine intention to use mobile banking in a new research setting, Vietnam.

2.3 Perceived risk and trust

While e-commerce is seen as an evolutionary form of traditional commerce, mobile commerce is seen as an evolutionary form of e-commerce (Hu et al., 2015; Ivanochko et al., 2015; Yang et al., 2015). Moreover, mobile banking is one of mobile commerce's most popular services (Kalinic and Marinkovic, 2016). Specifically, customers can conduct transactions and interactions with the bank via a mobile device (smartphone, tablet or PDA) connected to the wireless internet (Zhou, 2012). Due to the fact that banking transactions and interactions can be conducted anytime and anywhere, perceived risk has a greater degree and scope of influence in the mobile banking environment (Luo et al., 2010). Thus, perceived risk is considered a factor that influences customer behaviour in both the traditional commercial and e-commerce environments (Pavlou, 2003).

Perceived risk refers to situations in which unfavourable outcomes can occur, resulting in undesirable consequences for customers (Featherman and Pavlou, 2003). Traditional commerce is characterised by situations where customers interact directly with employees of the service provider, while with e-commerce customers interact with the service provider's website (Yang et al., 2004). E-customers find themselves dealing with an impersonal computer website where they have limited control of their data. Consequently, perceived risk in the e-commerce environment has a greater degree and scope than perceived risk in the traditional commercial environment where customers generally can withdraw at their discretion (Lee and Rha, 2016; Littler and Melanthiou, 2006).

The sources of perceived risk in the mobile banking environment may be from the bank itself or from a wireless internet service provider (Featherman and Pavlou, 2003; Zhao et al., 2008). The source of risk from the bank includes unreliable banking technology which leads to unfulfilled customer transactions, or customers' financial and personal information being misused or disclosed without customer permission. The source of risk from the wireless internet service provider includes dropped internet service or slow internet access speed, making customers spend a lot of time completing transactions and incurring opportunity costs.

Figure 1 Research model (see online version for colours)

In addition to perceived risks, trust is also a factor that is believed to influence mobile banking adoption (Lee et al., 2007; Oliveira et al., 2017). Trust in the mobile banking environment refers to the belief of customers that the bank has the ability, integrity and benevolence consistent with customers' expectations for the transaction's success (Koo and Wati, 2010). In any commercial setting, traditional, electronic or mobile, if there is no trust it is virtually impossible for customers to enjoy the level of success expected by stakeholders in transactions (Zhou, 2012). The mobile commerce environment in general and the mobile banking environment in particular are riskier and more uncertain (Eastin et al., 2016), so trust becomes more important than ever (Hanafizadeh et al., 2014). Trust increases customers' willingness to allow a certain level of vulnerability with transactions and interactions with the bank (Hillman and Neustaedter, 2017; Pavlou, 2003). Customers have a belief that the bank will not take advantage of them in transactions and interactions and that is the basis for mutual benefit for both customers and the bank (Luo et al., 2010).

Consistent with the importance of perceived risk and trust indicated by Pavlou (2003), Lee et al. (2007) and Luo et al. (2010), this study integrates them into the TAM to study intention to use mobile banking in Vietnam. Different from the majority of previous studies, but similar to Lee et al. (2007) and Luo et al. (2010), perceived risk in this study is considered as a second-order construct, including first-order constructs, i.e., component risk factors.

2.4 Research model

Based on theoretical foundations, namely the TAM and the variables of perceived risk and trust, the research model in this study is proposed in Figure 1. Figure 1 shows the relationships among perceived risk, trust, perceived ease of use, perceived usefulness and intention to use mobile banking. The following hypotheses are developed.

2.5 Research hypotheses

2.5.1 Perceived risk and trust

Perceived risk in the mobile banking environment refers to the situation in which there are uncertainties in customers' transactions and interactions with the bank (Pavlou, 2003). Perceived risk is related to unfavourable impacts which might happen from the results of customers' transactions and interactions with the bank (Featherman and Pavlou, 2003). Trust in refers to the belief of customers that the bank has the ability, integrity and benevolence consistent with customers' expectations for the transaction's success (Koo and Wati, 2010). Therefore, perceived risk is a factor that significantly affects customers' trust (Lee et al., 2007). While the level of perceived risk in the online banking environment is higher than in the traditional banking environment, the level of perceived risk in the mobile banking environment is higher than in the online banking environment (Luo et al., 2010). Mobile banking transactions and exchanges can be conducted anytime, anywhere through a wireless internet-connected mobile device, bringing benefits and challenges for both customers and the bank (Jun and Palacios, 2016). Sources of perceived risk can come from the bank's technology infrastructure and the wireless internet infrastructure (Featherman and Pavlou, 2003). Studies in online banking and mobile banking indicate that perceived risk is a second-order construct that includes first-order constructs – component risk factors such as time risk, financial risk, performance risk, social risk, security risk and privacy risk (Hanafizadeh et al., 2014; Lee et al., 2007; Luo et al., 2010). The results of these studies also indicate that perceived risk negatively affect customer trust in mobile banking (Gu et al., 2009; Lee et al., 2007). Therefore, the following hypothesis is proposed:

H1 Perceived risk has a negative relationship with trust.

2.5.2 Perceived risk and intention to use mobile banking

Hanafizadeh and Khedmatgozar (2012) argue that in the online banking environment, perceived risk is a second-order construct, composing of first-order constructs – component risk factors. Component risk factors include time risk, financial risk, performance risk, social risk, security risk and privacy risk. In the mobile banking environment, Lee et al. (2007) argue that perceived risk is a second-order construct, constituting first-order constructs – component risks: financial risk, psychological risk, time risk, security risk and privacy risk. Similarly, Luo et al. (2010) argue that in the mobile banking environment perceived risk as a second-order construct, including component risks such as performance risk, financial risk, time risk, psychological risk, social risk, physical risk, privacy risk and overall risk. Component risks have different contributions to perceived risk. Studies also show that in both online banking and mobile banking settings, perceived risk has negative effects on intention to use mobile banking

(Hanafizadeh et al., 2014; Luo et al., 2010; Pavlou, 2003; Yuan et al., 2014). Therefore, the following hypothesis is proposed:

H2 Perceived risk has a negative relationship with intention to use mobile banking.

2.5.3 Perceived risk and perceived usefulness

Thanks to great advances in communication and information technology in general and mobile technology and wireless internet in particular, customers are enjoying a wide range of utilities provided by mobile commerce (Yang et al., 2015). One of mobile commerce's most popular services is mobile banking (Chong et al., 2012). Customers do not need to go to physical bank branches to interact with the bank employees to complete mobile banking transactions (Jun and Palacios, 2016). Similarly, customers do not have to sit in front of a desktop computer to access the bank's website to complete mobile banking transactions (Zhou, 2012). In the mobile banking environment, customers are not limited by space and time; in other words, transactions can be completed anytime, anywhere. It is expected that mobile banking can bring significant benefits to customers, such as time savings, cost savings, increased comfort and convenience (Lee et al., 2007). However, the level of perceived risk in the mobile banking environment is greater than in both online banking and traditional banking environments (Luo et al., 2010). Certain component risks underlying perceived risk may have negative consequences that are enormous for customers, thereby, preventing customers from enjoying the benefits that mobile banking can bring to them. Studies in the mobile banking environment indicate that perceived risk has a negative effect on perceived usefulness (Luo et al., 2010). Therefore, the following hypothesis is proposed:

H3 Perceived risk has a negative relationship with perceived usefulness.

2.5.4 Trust and perceived ease of use

Trust is considered as an indispensable factor in any transaction or interaction in the traditional commercial, e-commerce, or mobile commerce setting (Pavlou, 2003). The success of transactions in these environments requires trust. Trust allows the trusting party to become vulnerable in exchanges and transactions with the trusted party (Featherman and Pavlou, 2003). Empirical evidence from studies on online banking and mobile banking shows that trust is positively associated with perceived ease of use (Pavlou, 2003). Therefore, the following hypothesis is proposed:

H4 Trust has a positive relationship with perceived ease of use.

2.5.5 Trust and intention to use mobile banking

While online banking is characterised by interactions between customers and the bank's website through an internet-connected desktop, mobile banking is characterised by customer interactions with the bank's website via a mobile device (smartphone, tablet or PDA) connected to the wireless internet (Changchit et al., 2017). With more unknowns, the mobile banking environment is clearly more uncertain and riskier than the online banking environment (Luo et al., 2010). Trust becomes more important than ever in the mobile banking environment (Lee et al., 2007). Trust is the foundation for success of interactions in general and transactions in the mobile banking environment in particular

(Koo and Wati, 2010). Circumstances that encourage trust reduce the obstacles presented by uncertainty and fear of personal loss, thereby increasing the inclination to engage in behaviour previously avoided. Evidence from empirical studies has shown that trust has a positive effect on intention to use mobile banking (Gu et al., 2009; Hanafizadeh et al., 2014; Lee et al., 2007; Luo et al., 2010; Pavlou, 2003). Therefore, the following hypothesis is proposed:

H5 Trust has a positive relationship with intention to use mobile banking.

2.5.6 *Trust and perceived usefulness*

In the mobile banking environment, the degree of uncertainty and risk is higher than in the online banking environment (Luo et al., 2010). Risks and uncertainties can come from sources such as technologies used by the bank in interacting with customers or from issues related to wireless internet infrastructure (Featherman and Pavlou, 2003). However, if customers trust in the bank, they are more likely to expect to enjoy many benefits from participating in transactions in the mobile banking environment. Perceptions of usefulness include customers who may possess beliefs that the bank has invested in its modern banking technology infrastructure to remove or minimise problems that may arise in interacting and communicating with customers and that mobile banking is something that should not be absent in one person's life because of the benefits it can bring. Evidence from empirical studies shows that trust has a positive effect on perceived usefulness (Gu et al., 2009; Koo and Wati, 2010; Lee et al., 2007; Pavlou, 2003; Luo et al., 2010). Therefore, the following hypothesis is proposed:

H6 Trust has a positive relationship with perceived usefulness.

2.5.7 *Perceived usefulness and intention to use mobile banking*

Perceived usefulness is defined as the degree to which the use of a certain technology will enhance someone's work results (Davis, 1989). Perceived usefulness has different names, for example, *performance expectancy* in UTAUT, or *relative advantage* in IDT. Empirical evidence indicates that perceived usefulness affects customer behaviour intentions in both e-commerce and mobile commerce environments (Pavlou, 2003). Mobile banking is one of mobile commerce's most popular services (Alfahl et al., 2017). In the mobile banking environment, customers can conduct banking transactions anytime, anywhere via a wireless internet-connected mobile device (Yuan et al., 2014). Empirical evidence also indicates that perceived usefulness has a positive effect on mobile banking adoption (Gu et al., 2009; Hanafizadeh et al., 2014; Lee et al., 2007; Luo et al., 2010; Pavlou, 2003; Yuan et al., 2014; Zhou et al., 2010). Consistent with the previous studies, the following hypothesis is proposed:

H7 Perceived usefulness has a positive relationship with intention to use mobile banking.

2.5.8 *Perceived ease of use and perceived usefulness*

In the TAM model, while perceived ease of use refers to a situation in which the use of a certain technology does not require a lot of effort, perceived usefulness refers to the situation in which a person believes that using a certain technology will improve his or

her work results (Davis, 1989). A series of studies have shown that perceived ease of use is positively related to perceived usefulness in both e-commerce and mobile commerce environments. Furthermore, empirical evidence has also shown that perceived ease of use is positively related to perceived usefulness in the mobile banking environment (Gu et al., 2009; Pavlou, 2003; Yuan et al., 2014; Zhou et al., 2010). Consistent with the results of these studies, the following hypothesis is proposed:

H8 Perceived easy to use has a positive relationship with perceived usefulness.

2.5.9 Perceived ease of use and intention to use mobile banking

In the TAM model, perceived ease of use and perceived usefulness are two key factors (Davis, 1989). Perceived ease of use is defined as the degree to which the use of a certain technology does not require great effort. Studies have shown that perceived use of use affects customer behaviour intentions in both e-commerce and mobile commerce environments (Pavlou, 2003). Mobile banking is an evolutionary form of online banking and is one of mobile commerce's most popular services (Kalinic and Marinkovic, 2016). Empirical evidence indicates that perceived ease of use has positive effects on intention to use mobile banking (Hanafizadeh et al., 2014; Gu et al., 2009; Pavlou, 2003). Consistent with the previous studies, the following hypothesis is proposed:

H9 Perceived ease of use has a positive relationship with intention to use mobile banking.

2.5.10 Control variables

Control variables in this study include gender, age and education level. These variables are believed to affect intention to use mobile banking in previous studies. These variables are controlled in order to analyse the various impacts of perceived risk, trust, perceived usefulness, perceived ease of use and perceived usefulness on mobile banking.

3 Research methodology

3.1 Survey instrument development

To assess the relationships among constructs in the research model, scales must be considered for content validity. The instrument's measurement scales must be evaluated, regarding content validity. Content validity refers to the extent to which the measurement scales are expected to measure what they are supposed to measure. The measurement scales in this study were borrowed from those of previous studies on online banking and mobile banking. These measurement scales have been confirmed in terms of reliability and validity.

One of the constructs in the research model is perceived risk. The perceived risk measurement scale was adapted from Featherman and Pavlou (2003), Lee et al. (2007) and Hanafizadeh and Khedmatgozar (2012) to suit the mobile banking environment. This scale includes component risks such as time risk, financial risk, performance risk, social risk, security risk and privacy risk. Each component risk factor includes three items. Perceived ease of use and perceived usefulness were adapted from Gu et al. (2009). Each

construct has four items. Trust was adapted from Lee et al. (2007) which include six items. The final construct was intention to use mobile banking. This construct's measurement scale was adapted from Hanafizadeh and Khedmatgozar (2012) to suit the mobile banking environment.

In addition to measurement scales for perceived risk, trust, perceived ease of use, perceived usefulness and intention to use mobile banking, customer demographic information was also included in the questionnaire, including gender, age, education, income and occupation.

The questionnaire was translated into Vietnamese by a banking expert who was fluent in both English and Vietnamese. The Vietnamese version of the questionnaire was translated back into English by another banking expert who was fluent in both English and Vietnamese to assess the consistency of both English and Vietnamese versions. The English and Vietnamese versions of the questionnaire were independently evaluated by two researchers who were fluent in both English and Vietnamese. The results showed that the translation content was accurate and consistent. The preliminary Vietnamese questionnaire was pre-tested using 45 customers who were using mobile banking. Based on these customers' feedback, some adjustments related to the wording were made to make the questionnaire clearer. The Likert scale with five levels in which 1 is 'completely disagree' and 5 is 'completely agree' were used to reflect customers' perception of mobile banking.

3.2 Data collection

Data collection employed a convenience sample using customers of one of the largest commercial banks in Vietnam. Convenience sampling is a common method of research on marketing, management information systems and management. With the bank's branch managers' help, the branches' employees approached customers who came to conduct banking transactions in Hanoi, capital of Vietnam. The purpose of this research was explained and customers were asked if they would participate in the survey as part of an effort to enhance the bank's mobile services. The questionnaires were delivered directly from the bank staff to customers who were currently using mobile banking services. The data collection process was completed in July 2018. The customers completed the questionnaire at the bank branches and returned it to the bank staff. There were 403 valid responses that could be used for subsequent statistical analyses. The respondents' demographic information is provided in Table 1.

Table 1 shows that male respondents account for 46.2% of the sample. 56.3% of the respondents were under 30 years old. Regarding the respondents' highest education level, 59.1% had a bachelor's degree, while 21.8% had master's degree or PhD. With respect to the respondents' average monthly income, the majority (83.5%) had income below \$1,000. 57.1% of the respondents worked in the private sector.

The most complicated construct in the research model is perceived risk, consisting of six first-order constructs (component risk factors). So, the minimum sample size needed to have reliable results when applying the PLS estimation method is $6 \times 10 = 60$ (ten times the most complicated construct's components) (Chin, 1998). The actual sample size in this study is 403, satisfying the requirement.

One of the concerns in research using survey is non-response bias. In order to assess if non-response bias exists in this study, *t*-tests were conducted according to the suggestions of Armstrong and Overton (1977). The results of *t*-tests showed there was no

significant difference between the early response group and the late response group on key measures at the 5% significance level. This indicated that non-response bias did not appear to be a serious problem in this study.

Table 1 Characteristics of the survey respondents

<i>Characteristic</i>	<i>Subgroup</i>	<i>Number of respondents</i>	<i>Proportion</i>
Gender	Male	186	46.2
	Female	217	53.8
Age	Less than 20	31	7.7
	20–29	196	48.6
	30–39	128	31.8
	40 or over	48	11.9
Education	High school	77	19.1
	Bachelor	238	59.1
	Master degree or above	88	21.8
Monthly income	Less than \$300	104	25.8
	300–499	92	22.8
	500–999	141	34.9
	1,000 or more	66	16.5
Occupation	The governmental and state sector or educational institutions	59	14.6
	The private sector's organisations	230	57.1
	Working for themselves or not having a job	114	28.3

3.3 *Statistical techniques*

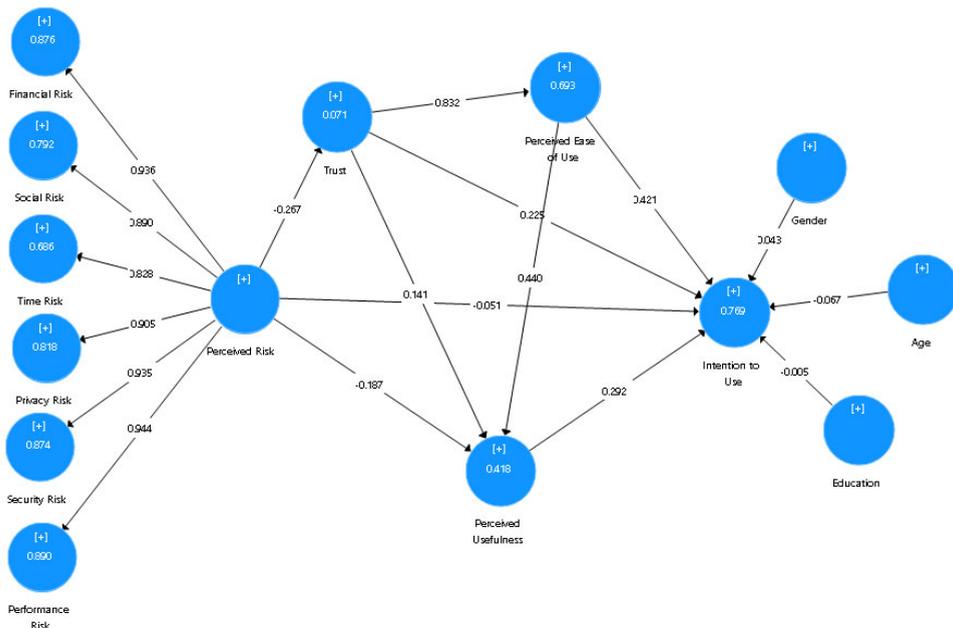
In this study, in addition to statistical techniques such as descriptive statistics, correlation coefficients and factor analysis, the structural equation modelling method was used to estimate the path coefficients representing the relationships among constructs. This study also followed Bollen's (1989) two-step process in which the measurement model was evaluated in Step 1. In Step 2, the hypotheses were tested through the evaluation of structural modelling. The statistical software used in this study included SPSS 25 and SmartPLS 3.

4 **Results**

Based on the suggestion of Bollen (1989), in Step 1, the measurement model was evaluated. First, a Harmon test was conducted (Podsakoff et al., 2003) to consider whether common method bias existed in the sample. According to this method, all items measuring constructs were loaded onto only one factor. The results showed that this single factor explained less than 50% of the variability, indicating that common method bias did not exist. Before analysing the measurement model, descriptive statistics of items constituting the constructs were considered. Results showed no outliers.

The measurement model was evaluated based on factor analysis using SmartPLS 3. Reliability, convergent validity and discriminant validity were examined. After eliminating the three items of trust, two items of perceived ease of use and two items of perceived usefulness (because their VIF values were greater than 5 or loading values were less than 0.6) (Kock, 2015), the measurement model showed high reliability, convergent validity and discriminant validity. Convergent validity is confirmed when all loading values are greater than or equal to 0.6 (Bagozzi and Yi, 1988). Table 2 shows all loading values of each factor were greater than 0.8. Reliability of constructs was expressed through Cronbach’s alpha (CA) coefficients, composite reliability (CR) coefficients and average variance extracted (AVEs). CAs values and CR coefficients were greater than 0.8 and the values of AVEs were greater than 0.7, indicating that the measurement scales have a high level of reliability.

Figure 2 Path coefficient estimates and R-square values (see online version for colours)



Discriminant validity was evaluated by comparing the square root of a factor’s AVE with the correlation coefficients of this factor with other factors. Table 3 shows the square root values of AVEs (located on the diagonal) and the correlation coefficients among the factors. As shown in Table 3, the square root value of a factor’s AVE is greater than the correlation coefficients of this factor with the other factors. This indicates that discriminant validity is confirmed for the measurement model.

Discriminant validity of the measurement model can be also evaluated based on the heterotrait-monotrait (HTMT) values. Table 4 shows that the HTMT values are less than 0.85. This once again confirms the measurement model’s discriminant validity.

Table 2 Loadings, CA, CR and AVE

<i>Item</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
FIN1	0.893									
FIN2	0.896									
FIN3	0.888									
IU1		0.895								
IU2		0.909								
IU3		0.89								
IU4		0.942								
PER1					0.846					
PER2					0.861					
PER3					0.863					
PEU2			0.924							
PEU4			0.963							
PRI1						0.88				
PRI2						0.829				
PRI3						0.872				
PU1				0.934						
PU4				0.916						
SEC1							0.862			
SEC2							0.837			
SEC3							0.862			
SOC1								0.864		
SOC2								0.837		
SOC3								0.876		
TRU1										0.926
TRU2										0.893
TRU6										0.818
TIM1									0.833	
TIM2									0.841	
TIM3									0.857	
CA	0.922	0.950	0.941	0.922	0.892	0.895	0.890	0.894	0.881	0.910
CR	0.922	0.950	0.942	0.922	0.892	0.895	0.890	0.894	0.881	0.911
AVE	0.797	0.827	0.890	0.856	0.734	0.741	0.729	0.738	0.712	0.774

Notes: 1: Financial risk, 2: intention to use, 3: perceived ease of use, 4: perceived usefulness, 5: performance risk, 6: privacy risk, 7: security risk, 8: social risk, 9: time risk, 10: trust, CA: Cronbach's alpha, CR: composite reliability and AVE: average variance extracted.

Table 3 Correlations and AVEs

<i>Construct</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
FR	0.893									
IU	-0.36	0.909								
PEU	-0.297	0.825	0.943							
PU	-0.346	0.712	0.617	0.925						
PER	0.897	-0.347	-0.308	-0.363	0.857					
PRI	0.743	-0.353	-0.303	-0.396	0.73	0.861				
SEC	0.767	-0.294	-0.246	-0.315	0.781	0.783	0.854			
SOC	0.675	-0.267	-0.222	-0.263	0.668	0.733	0.805	0.859		
TIM	0.673	-0.23	-0.261	-0.192	0.7	0.605	0.608	0.67	0.844	
TRU	-0.237	0.764	0.832	0.558	-0.221	-0.255	-0.196	-0.187	-0.306	0.88

Notes: 1: Financial risk (FR), 2: intention to use (IU), 3: perceived ease of use (PEU), 4: perceived usefulness (PU), 5: performance risk (PER), 6: privacy risk (PRI), 7: security risk (SEC), 8: social risk (SOC), 9: time risk (TIM) and 10: trust (TRU).

Table 4 HTMT values

<i>Construct</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
FR	-									
IU	0.36	-								
PEU	0.297	0.825	-							
PU	0.346	0.712	0.617	-						
PER	0.897	0.348	0.308	0.364	-					
PRI	0.742	0.354	0.303	0.396	0.729	-				
SEC	0.767	0.295	0.247	0.316	0.781	0.783	-			
SOC	0.674	0.267	0.222	0.262	0.668	0.733	0.804	-		
TIM	0.673	0.23	0.261	0.192	0.699	0.605	0.607	0.67	-	
TRU	0.236	0.764	0.833	0.557	0.222	0.254	0.195	0.186	0.307	-

Notes: 1: Financial risk (FR), 2: intention to use (IU), 3: perceived ease of use (PEU), 4: perceived usefulness (PU), 5: performance risk (PER), 6: privacy risk (PRI), 7: security risk (SEC), 8: social risk (SOC), 9: time risk (TIM) and 10: trust (TRU).

After reliability, convergent validity and discriminant validity of the measurement model were confirmed, in Step 2, the hypotheses were verified through the analysis of structural model. Figure 2 shows the path coefficient estimates and *R*-square values and Figure 3 shows the *t*-value estimates for path coefficients.

As shown in Figure 2, perceived risk is a second-order construct, including first-order constructs as component risks. The path coefficients from perceived risk to risk components are positive. Moreover, the path coefficients from perceived risk to trust, perceived usefulness and intention to use mobile banking are negative. The path coefficients from trust to perceived ease of use, perceived usefulness and intention to use mobile banking are positive. The path coefficients from perceived ease of use to

perceived usefulness and intention to use mobile banking are positive. The path coefficient from perceived usefulness to intention to use mobile banking is positive. The *R*-square values are shown in each endogenous variable's circle. In Figure 3, most *t*-value estimates are greater than two.

Figure 3 Estimates of *t*-values (see online version for colours)

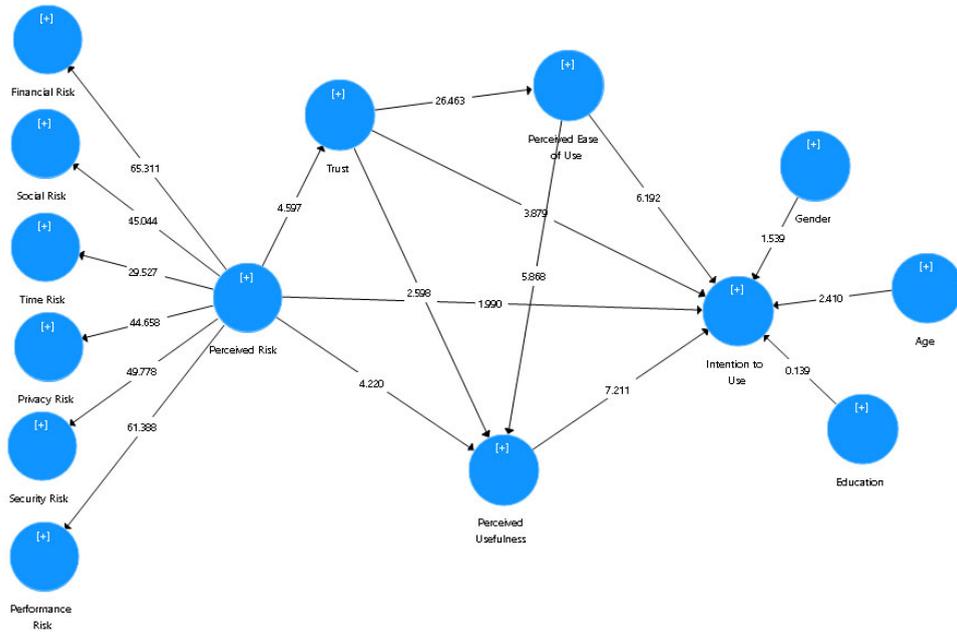


Table 5 Hypotheses test results

<i>Relationship</i>	<i>Hypothesis</i>	<i>Path coefficient</i>	<i>t-value</i>	<i>p-value</i>	<i>Result</i>
PR → TRU	H1	-0.267	4.597	0.000***	Accept
PR → IU	H2	-0.051	1.990	0.047*	Accept
PR → PU	H3	-0.187	4.220	0.000***	Accept
TRU → PEU	H4	0.832	26.463	0.000***	Accept
TRU → IU	H5	0.225	3.879	0.000***	Accept
TRU → PU	H6	0.141	2.598	0.010**	Accept
PU → IU	H7	0.292	7.211	0.000***	Accept
PEU → PU	H8	0.440	5.868	0.000***	Accept
PEU → IU	H9	0.421	6.192	0.000***	Accept

Notes: PR: Perceived risk, IU: intention to use, PEU: perceived ease of use, PU: perceived usefulness and TRU: trust. **p* < 0.05, ***p* < 0.1 and ****p* < 0.01.

Based on Figure 2 and Figure 3, the results of hypotheses testing are summarised in Table 5. The results show that all Hypotheses H1, H2, H3, H4, H5, H6, H7, H8 and H9 are statistically supported. For control variables, age affects intention to use mobile banking; however, the size of this effect is not significant because its *f*-square is small, 0.018.

5 Discussion and implications

5.1 Discussion

The results of this study show that perceived risk is a second-order construct which consists of component risk factors such as financial risk, social risk, time risk, privacy risk, security risk and performance risk. The path coefficient from perceived risk to financial risk is 0.936 (t -value, 65.311, p -value < 0.001), social risk 0.890 (t -value, 45.044, p -value < 0.001), time risk 0.828 (t -value, 29.527, p -value < 0.001), privacy risk 0.905 (t -value, 44.658, p -value < 0.001), security risk 0.935 (t -value, 49.778, p -value < 0.001) and performance risk 0.944 (t -value, 61.388, p -value < 0.001). Perceived risk explains 87.6% of the variability of financial risk, 79.2%, social risk, 68.6%, time risk, 81.8%, privacy risk, 87.4%, security risk, and 89%, performance risk. The path coefficients from perceived risk to component risks have p -values of less than 1%.

All of these statistics indicate that perceived risk in the mobile banking environment in Vietnam is a second-order construct, including first-order constructs or component risks: financial risk, social risk, time risk, privacy risk, security risk and performance risk. These results are basically the same as those of Lee et al. (2007) and Luo et al. (2010). Lee et al. (2007) combining of financial risk and performance risk into financial performance risk and psychological risk in Lee et al. (2007) is similar to social risk in this study. In addition to performance risk, financial risk, time risk, social risk and privacy risk, Luo et al. (2010) also investigated psychological risk, physical risk and overall risk. However, the current study argues that psychological risk and social risk are not much different. Physical risk does not exist in a practical sense with regard to negative impacts on customers and overall risk is similar to perceived risk, a second-order construct. Thus, the current study does not examine these risks.

The path coefficient of perceived risk to trust is -0.267 (t -value, 4.597, p -value < 0.001, f^2 , 0.077). This indicates that H1: Perceived risk has a negative relationship with trust in Vietnam's mobile banking setting is statistically supported. This result is similar to the results of Gu et al. (2009) and Lee et al. (2007). The path coefficient of perceived risk to intention to use mobile banking is -0.051 (t -value, 1.990, p -value < 0.05, f^2 , 0.009), indicating that H2: Perceived risk has a negative relationship with intention to use mobile banking in Vietnam's mobile banking setting is statistically supported. This result is similar to Luo et al. (2010), Yuan et al. (2014), Hanafizadeh et al. (2014) and Pavlou (2003).

The path coefficient of perceived risk to perceived usefulness is -0.187 (t -value, 4.220, p -value < 0.01, f^2 , 0.054), indicating that H3: Perceived risk has a negative relationship with perceived usefulness in Vietnam's mobile banking setting is statistically supported. This result is similar to Luo et al. (2010). The path coefficient of trust to perceived ease of use is 0.832 (t -value, 26.463, p -value < 0.01, f^2 , 2.257), indicating H4: Trust has a positive relationship with perceived ease of use in Vietnam's mobile banking setting is statistically supported. This result is similar to Pavlou (2003).

The path coefficient of trust to intention to use mobile banking is 0.225 (t -value, 3.879, p -value < 0.01, f^2 , 0.062), indicating that H5: Trust has a positive relationship with intention to use mobile banking in Vietnam's mobile banking setting is statistically supported. This result is similar to that of Pavlou (2003), Luo et al. (2010), Gu et al. (2009), Hanafizadeh et al. (2014) and Lee et al. (2007). The path coefficient of trust to perceived usefulness is 0.141 (t -value, 2.598, p -value < 0.05, f^2 , 0.011), indicating that

H6: Trust has a positive relationship with perceived usefulness in Vietnam's mobile banking setting is statistically supported. This result is similar to that of Pavlou (2003), Lee et al. (2007), Luo et al. (2010), Gu et al. (2009) and Koo and Wati (2010).

The path coefficient of perceived usefulness to intention to use mobile banking is 0.292 (t -value, 7.211, p -value < 0.01, f^2 , 0.213), indicating that H7: Perceived usefulness has a positive relationship with intention to use mobile banking in Vietnam's mobile banking setting is statistically supported. This result is similar to that of Pavlou (2003), Lee et al. (2007), Luo et al. (2010), Gu et al. (2009), Yuan et al. (2014), Hanafizadeh et al. (2014) and Zhou et al. (2010). The path coefficient of perceived ease of use to perceived usefulness is 0.440 (t -value, 5.868, p -value < 0.01, f^2 , 0.099), indicating that H8: Perceived ease of use has a positive relationship with perceived usefulness in Vietnam's mobile banking setting is statistically supported. This result is similar to that of Pavlou (2003), Gu et al. (2009), Yuan et al. (2014) and Zhou et al. (2010).

The path coefficient of perceived ease of use to intention to use mobile banking is 0.421 (t -value, 6.192, p -value < 0.01, f^2 , 0.196), indicating that H9: Perceived ease of use has a positive relationship with intention to use mobile banking in Vietnam's mobile banking setting is statistically supported. This result is similar to that of Pavlou (2003), Gu et al. (2009) and Hanafizadeh et al. (2014).

The unique contribution of this study is that this study is considered one of the first comprehensive and systematic studies on intention to use mobile banking in a newly emerging country, Vietnam, on the basis of integrating perceived risk and trust into the TAM. This integrated model has a very high predictive power, explaining more than 76% of the variability of intention to use mobile banking. The study shows that in Vietnam's mobile banking setting, perceived risk is a second-order construct, including first-order constructs as component risk factors. Therefore, strategies and programs that reduce perceived risk on the basis of reducing component risks can play an important role in improving trust, perceived usefulness and intention to use mobile banking in Vietnam.

5.2 Implications

The results of this study indicate that perceived risk is negatively related to trust, perceived usefulness and intention to use mobile banking. Therefore, in order to increase trust, perceived usefulness and intention to use mobile banking, banks must implement strategies and action plans aimed at reducing perceived risk. Furthermore, this study also shows that perceived risk is a second-order construct, consisting of first-order constructs as component risk factors. Thus, reducing perceived risk means reducing component risks.

Among component risk factors, performance risk (path coefficient, 0.944) and financial risk (path coefficient, 0.936) contribute the most to perceived risk. Performance risk refers to situations in which the mobile banking system operates inefficiently and ineffectively. The mobile banking system's inefficiency and effectiveness may be due to a server's sudden shutdown for unexplained reasons, slow wireless internet speed, or similar factors resulting in inability to complete interactions and transactions related to customer accounts. This results in perceptions of the banking system's unreliability or banking service quality that do not meet customer expectations. Financial risk relates to situations in which financial losses may occur to customers due to inputting incorrect information relating to customer account numbers or amounts of money or transaction errors stemming from the mobile banking system's inaccuracy.

To reduce performance risk and financial risk, banks providing mobile banking services need to invest in building a modern mobile banking technology infrastructure to ensure that all operations, transactions and exchanges can take place continuously and accurately. It must be aware that the profitability potential from mobile banking is huge and deserving of this investment. With modern equipment used for banking services in general and mobile banking services in particular, customers' increasing expectations and demands can be met satisfactorily. Moreover, it is important to build an organisational culture in the bank that always puts the interests of customers first. The system must be capable of providing specific instructions and detailed steps for any mobile banking transaction that can be conducted by customers. Moreover, it is necessary to clearly define customer rights and the bank's responsibility when dealing with transaction errors. The bank must actively detect and handle errors to help ensure benefits for customers. In any case, the interests of customers must be the bank's top priority.

Security risk (path coefficient, 0.935) and privacy risk (path coefficient, 0.905) have the second most significant contribution to perceived risk. In the mobile banking environment, customers can conduct transactions anytime, anywhere through a mobile device connected to the wireless internet. The level of security risk and privacy risk is greater than that in the traditional and online banking environments. To complete mobile banking transactions, customers are often required to provide personal and financial information. These two types of risks refer to situations where customer personal and financial information may be stolen, unlawfully modified, or used without customer permission. If these actions occur, the loss to customers can be very serious. In order to reduce security risk and privacy risk, banks providing mobile banking services must employ encryption systems with advanced algorithms, firewalls and multi-tiered authentication procedures. For each customer mobile banking transaction, the bank employees' duties and responsibilities must be clearly specified and the bank must build an organisational culture where the interests of customers are always put first. In addition, the bank must communicate clearly, consistently and accurately that the customer's personal and financial information is always protected and that the customer's interests are of the utmost importance to the bank in any mobile transaction.

Social risk (path coefficient, 0.890) contributes to perceived risk. Social risk relates to situations in which customers feel their position in the eyes of friends, colleagues, family members, or members of forums on social networks is reduced when encountering problems or errors relating to mobile banking services because these reference groups may not have a positive attitude towards the use of mobile banking services. To reduce this risk, banks must implement action plans and marketing programs towards the public and customers to convey messages that mobile banking is an irreversible trend in the evolution of mobile commerce, mobile banking benefits both the customers and the bank, and the bank with its modern mobile banking technology infrastructure ensures smooth and accurate mobile banking transactions.

Time risk relates to situations in which customers perceive that they have to spend too much time learning how to use the mobile banking system, dealing with errors in transactions and exchanges, or completing transactions and exchanges. To reduce this risk in the eyes of customers, the bank must once again implement effective marketing programs to deliver messages to the public and customers that the bank has been investing in building a modern mobile banking system and transactions and interactions in the mobile banking environment can be conducted simply, quickly and accurately. Furthermore, these messages must also emphasise that clear instructions and steps taken

for each specific mobile banking transaction exist on the bank's website and compliance with these instructions and steps does not take much time.

This study also shows that trust has positive relationships with perceived ease of use, perceived usefulness and intention to use mobile banking. Therefore, the bank must find ways to improve trust. Trust is an important factor in determining the success of traditional, online, or mobile commerce. Expectations for the success of interactions and transactions require trust. Trust is the foundation that further fosters the relationship between customers and the service provider. Trust helps customers become more open to transactions and interaction with the service provider. Evidence from empirical studies indicates that trust is a factor that influences the use of online services or the adoption of a new technology in the e-commerce environment. In the mobile banking environment, trust is the cornerstone motivating customers to use mobile banking services (Gu et al., 2009; Hanafizadeh et al., 2014; Lee et al., 2007; Luo et al., 2010).

In order to increase trust in the mobile banking environment, the bank must invest in building a banking technology infrastructure in general and mobile banking technology infrastructure in particular, ensuring that all banking transactions, including mobile banking transactions are conducted accurately, smoothly and quickly. Communication and marketing strategies must be effectively implemented to convey messages to customers that the bank's reputation and capability are reflected in its modern banking equipment that is always in a state of readiness to satisfy customer expectations and requirements. Moreover, the messages to the public and customers must also emphasise that the bank's organisational culture always puts the interests of customers first and the bank has its ability, integrity and benevolence in meeting its customers' increasing expectations and demands.

In this study, perceived ease of use has a positive relationship with perceived usefulness and intention to use mobile banking and perceived usefulness has a positive relationship with intention to use mobile banking. Thus, the bank needs to build a simple and efficient mobile banking interface to make customers feel that using mobile banking does not take much effort and that transactions and interactions can be completed in a quick, accurate and convenient way. In addition, the information on the bank's website must be reasonably arranged to facilitate customers' search for necessary information and to allow simple completion of mobile banking transactions. By doing so, customers will perceive that using mobile banking does not take much effort but allows the user to enjoy a variety of benefits, leading to an increase in intention to use mobile banking.

6 Conclusions and limitation

This study integrates perceived risk and trust into the TAM. This integrated model has been confirmed based on data from customers of one of the largest joint stock commercial banks in Vietnam. Through a convenience sample with 403 respondents, the results from statistical analyses show that the integrated model explains more than 76% of the variability of intention to use mobile banking. The results also show that perceived risk is negatively related to trust, perceived usefulness and intention to use mobile banking. Perceived risk is a second-order construct, consisting of component risk factors (in order of contribution to perceived risk), performance risk, financial risk, security risk, privacy risk, social risk and time risk.

Moreover, trust is positively associated with perceived ease of use, perceived usefulness and intention to use mobile banking. Perceived ease of use is positively associated with perceived usefulness and intention to use mobile banking. Perceived usefulness is positively related to intention to use mobile banking. Implications have been drawn to enhance intention to use mobile banking. However, some limitations exist in this study.

First, the sample in this study was a convenience sample of customers of a joint stock commercial bank in Vietnam. Therefore, generalisation of these results to other banks in Vietnam or to other banks in other newly emerging countries should be implemented with caution. Future research should collect data from customers of other commercial banks in Vietnam and other newly emerging countries to validate the results of this study.

Second, a developed country's mobile banking environment might be different from a newly emerging country's mobile banking environment. Thus, to shed light on this possibility, future research can be conducted to compare perceived risk, trust, perceived ease of use, perceived usefulness and intention to use mobile banking between a developed country and a newly emerging country.

Third, perceived risks can have different effects on different stages of mobile banking adoption. Future research can be carried out to validate this proposition.

Fourth, although the integrated model in this study explains more than 76% of the variability of intention to use mobile banking, there may be other important explanatory variables that have not been analysed in the model. Future research can extend the integrated model by considering whether trust is a second-order construct, consisting of first-order constructs as component trust factors and analysing the contributions of these component trust factors to overall trust to see which component trust factors are the most important.

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