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Abstract

Purpose – The purpose of this paper is to examine and quantify how various uncertainties result in different perceived risk dimensions that hinder mobile payment (m-payment) acceptance.

Design/methodology/approach – An uncertainty-risk-value framework was proposed based on perceived risk theory, prospect theory, and perceived value theory. Structural equation modeling method was used to test the research model.

Findings – Perceived information asymmetry, perceived technology uncertainty, perceived regulatory uncertainty, and perceived service intangibility are confirmed as the main determinants of perceived risk, while perceived performance risk, perceived financial risk, and perceived privacy risk were found to have strong negative effects on perceived value and acceptance intention.

Practical implications – The findings may help businesses and policy makers better understand the sources of perceived risk and help support the development of appropriate strategies to mitigate the risk concerns consumers have regarding m-payment.

Originality/value – Although the hindering effects of perceived risk regarding m-payment acceptance have been confirmed in previous studies, the sources of perceived risk were rarely investigated. By examining the determinants of perceived risk in m-payment acceptance, this paper offers insights into how consumers perceive risks when adopting new innovations. Additionally, it bridges the gap between the antecedents and consequences of perceived risk.

Keywords Perceived value, Perceived risk, Consumer acceptance, Mobile payment, Perceived uncertainty

Paper type Research paper

1. Introduction

The past several years witnessed the popularity of mobile commerce applications, such as mobile shopping, mobile travel service, online to offline (O2O) consumption, etc. The prosperity of mobile commerce heavily relies on the consumer acceptance of mobile payment (m-payment), conducted via mobile terminals, e.g. a mobile phone or personal digital assistant. Currently, the huge potential market for m-payment has attracted various service providers in China to offer m-payment services. For example, Alipay, the most popular third-party online payment platform, recently released its

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Alipay Wallet. WeChat, the main competitor of Alipay, also incorporated m-payment into its system. Major telecommunication operators in China, including China Mobile, China Unicom, and China Telecom, have developed their own m-payment services as well.

In spite of the availability of various m-payment services in China, the adoption rate is still lower than expected. According to the Ministry of Industry and Information Technology of China (MIIT, 2014), by January 2014 there were 1.23 billion mobile phone subscribers and 0.84 billion mobile internet subscribers in China, but only 25.1 percent of the Chinese mobile phone users use m-payment, which is much lower than the enormous market. Therefore, there is a need to examine what prevents consumers from adopting m-payment, which will be valuable for Chinese m-payment service providers wishing to promote m-payment acceptance.

Prior studies on m-payment acceptance mainly investigate the motivations behind using m-payment, and have done so by employing the dominant information system adoption theories, such as the technology acceptance model (Kim *et al.*, 2010; Schierz *et al.*, 2010). However, only limited attention has been paid to studying inhibitors like perceived risk. Though the majority of consumers seem aware of the potential benefits of m-payment, like ease of use, usefulness, and convenience, it seems they may have strong concerns about the potential risks of adopting m-payment. These concerns may adversely affect their acceptance of m-payment. According to prospect theory, people value the same amount of loss as being more significant than they would value the same amount of gain in uncertainty situations (Kahneman and Tversky, 1979). In addition, according to the certainty effect of prospect theory, people tend to stop trying a new risky payment manner if the current ones still work.

Therefore, the research on the inhibitors as well as the motivators of m-payment adoption is required. It is worth noting that prior studies have validated the negative effects of perceived risk on m-payment acceptance (Chandra *et al.*, 2010; Martins *et al.*, 2014). However, little is known regarding how perceived risks in m-payment formulate. The sources of perceived risks in m-payment are still unclear, although understanding the sources of perceived risks is necessary for service providers and policy makers to develop more effective measures to relieve consumer risk concerns. Prior literature sought to investigate the antecedents that negatively affect perceived risk in contexts like banking services or online shopping (Li and Bai, 2010; Kim and Lennon, 2013; Mann and Sahni, 2013). In contrast, this research will contribute to the literature by adopting a novel perspective of perceived uncertainty, which quantifies the sources of perceived risk that exhibit a positive and incremental effect.

Considering the research gap, the paper aims to examine how perceived risks are derived from various uncertainties. It also explores and quantifies how the different dimensions of perceived risk affect the value perception of m-payment and hinder consumers to adopt m-payment.

2. Literature review

2.1 Perceived risk theory

Bauer (1960) suggested most consumer procurement behavior might be risky because purchase decisions might lead to unpredictable or unfavorable consequences. The uncertainty of the occurrence of unpleasant consequences can result in perceived risk (Bauer, 1960). Cox and Rich (1964) argued that perceived risk consists of perceptions about the interests and the uncertainties involved in the buying decision. If the desired purchase objectives are not achieved, a consumer will experience

unfavorable consequences. Generally, researchers define perceived risk based on their own research contexts, e.g., Forsythe and Shi (2003) define perceived risk as a buyer's the subjective expectation of possible losses when making decisions of about online shopping. In this study perceived risk refers to the extent to which consumers perceive the possible losses that could be created due to the uncertainties of using m-payment. The losses include any unfavorable consequences to consumer, such as financial loss, the violation of privacy, dissatisfaction with performance, psychological anxiety or discomfort, wasting time.

Many studies have tested the influence of perceived risk on various innovation adoptions, such as internet shopping (Forsythe and Shi (2003), e-services (Featherman and Pavlou (2003), and electronic business (Kim *et al.* (2008). However, only a few are available about the sources of perceived risk. Mitchell (1999) proposed that perceived risk is caused by certain types of uncertainties. Lim (2003) suggested three sources of perceived risk, including technology, vendor, and product in e-commerce. Conchar *et al.* (2004) noted that the inherent uncertainty of a specific situation is the main source. It is also indicated that perceived uncertainty may possibly induce perceived risk in the online context (Pavlou *et al.*, 2007). Li and Bai (2010) argued usability is the basic factor behind perceived risk in mobile banking. These studies just qualitatively provide some insights on the antecedents of perceived risk. Laroche *et al.* (2004) found that the intangibility of services substantially incurs consumer perceived risk. Mann and Sahni (2013) reported the negative influences of trust and loyalty on perceived risk in online banking. In another study, web site quality was found to be negatively related to perceived risk in the online shopping context (Kim and Lennon, 2013). However, limited knowledge is available on the determinants that have an incremental effect on perceived risk in the mobile services context.

2.2 Prospect theory

The prospect theory indicates that individuals make decisions based on value function under the condition of uncertainty (Kahneman and Tversky, 1979). According to the theory, people are more sensitive to losses than gains when facing a risky choice. Consequently, a consumer's perception of potential losses may play a more important role in the adoption of innovative services. In addition, in the evaluation stage of the decision-making process, the choice maker needs a reference point based on which losses and gains can be calculated, and a reference point that is consistent with the conception of perceived sacrifices and perceived benefits in the perceived value theory (Wood and Scheer, 1996; Kim *et al.*, 2007). Constantiou (2009) investigated the referencing and reasoning process of consumer adoption of mobile services from the perspective of prospect theory. Chiu *et al.* (2014) also examined the moderating effects of perceived risk on the relation between perceived value and purchase intention based on prospect theory. In this regard, prospect theory contributes to the theoretical basis for the relationship between perceived risk and perceived value in our study

2.3 Perceived value theory

Zeithaml (1988) define perceived value as "the consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given," which is widely accepted in marketing fields. Consumers typically cannot accurately assess the objective value of goods, but make decisions on perceived value, i.e., the subjective evaluation of the total benefits and losses of and for the offering (Dodds and Monroe,

1985; Zeithaml, 1988). Dodds and Monroe (1985) first tested the relationships between price, sacrifice, perceived quality, perceived value, and willingness to buy. Thereafter, Wood and Scheer (1996) incorporated perceived risk into that model, forming the perceived value theory model. Based on perceived value theory, Kim *et al.* (2007) regarded usefulness, enjoyment, technicality, and perceived fee as the antecedents of perceived value in order to explain the adoption of the mobile internet. Another study incorporated convenience, user control, compatibility, risk, and cognitive effort into the perceived value model to investigate mobile service delivery (Kleijnen *et al.*, 2007).

3. Research model and hypotheses

A research model was developed based on perceived risk theory, prospect theory and perceived value theory. Prospect theory and perceived value theory provide the rationale for the relationships between perceived risk, perceived value, and acceptance intention. Perceived uncertainty-perceived risk relationships were inferred from perceived risk theory and relevant research. The research model is depicted in Figure 1.

3.1 Perceived risk of m-payment

Previous studies indicate that perceived risk is a multi-dimensional construct in e-commerce contexts (Featherman and Pavlou, 2003; Lim, 2003; Martins *et al.*, 2014). We adopt a five-dimensional measurement of perceived risk in m-payment, including perceived financial risk, privacy risk, performance risk, psychological risk, and time risk, which is consistent with the work of Featherman and Pavlou (2003).

3.1.1 Perceived financial risk. Perceived financial risk refers to consumer perception about the possible monetary loss caused by the usage of m-payment (Featherman and Pavlou, 2003). The transfer of money between accounts in m-payment may raise great concern about financial information, such as accounts and passwords being stolen and the subsequent the risk of losing money. M-payment usually applies wireless communication technologies that potentially keep the exposure of financial information to potential intruders. Additionally, tampering two-dimension code (2D code) scanning in m-payment may also contain malicious software that is used to illegally acquire

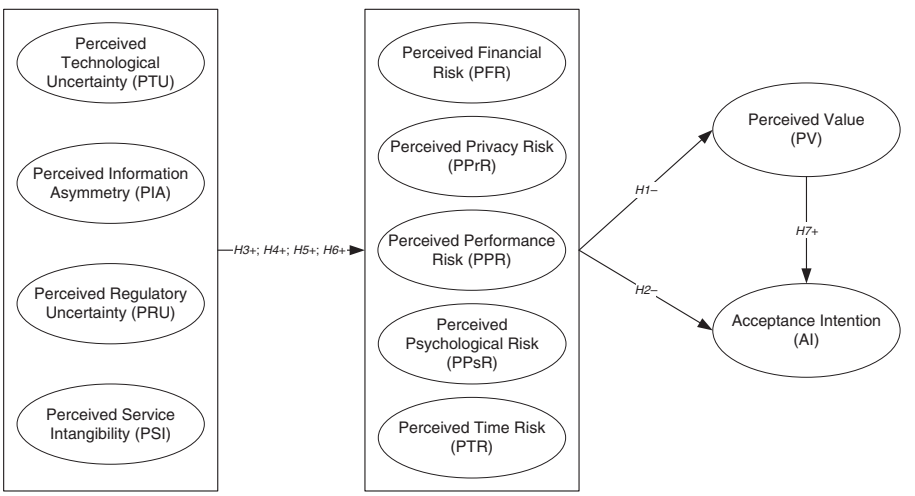


Figure 1.
Uncertainty-risk-value framework (URVF)

payment accounts and passwords. Consumers may be unsure about the encryption of information and the authentication of m-payment, which potentially increases their worries about financial risk regarding m-payment.

3.1.2 Perceived privacy risk. Privacy is another major consumer concern in m-payment adoption because much private information, like phone numbers, social security numbers, pin code, consumption locations, shopping records, etc., is required in the m-payment process. Such information could be exposed or maliciously used if it fell into the wrong hands. The perception of the possible exposure of a user's private information is termed perceived privacy risk (Featherman and Pavlou, 2003). The potential violations of a consumer's privacy information include service providers intentionally collecting, disclosing, transmitting, or selling personal data without a consumer's knowledge or permission or hackers intercepting such information.

3.1.3 Perceived performance risk. Perceived performance risk refers to user's perception about the possibility of the m-payment system malfunctioning and not working as intended or advertised, and thus being unable to provide the desired services (Featherman and Pavlou, 2003). Furthermore due to speed limitations and the availability of a wireless network, the performance of m-payment is sometimes unstable. For instance, system failure can result in an incomplete transaction when using a mobile app after taking a taxi. Additionally, screen size limitations and the processing capability of mobile phones may also raise user concerns.

3.1.4 Perceived psychological risk. Perceived psychological risk refers to consumer's perception of any possible psychological frustration, pressure, or anxiety resulting from the use of m-payment (Lim, 2003). M-payment is a relatively new and complicated service compared with wired internet payment or credit-card payment. Thus, users may be unable to operate the software successfully, which can induce psychological pressure. Additionally, the difficulty of keeping payment evidence in cell phones and their wireless characteristics may induce anxiety in general users if a transaction is not successful.

3.1.5 Perceived time risk. Perceived time risk refers to any possible time loss due to the usage of m-payment. This may result from uncertainties about the time required to learn how to operate the software, which procedures to follow when failing to pay bills, or how to delete mobile apps when their performance is below expectations (Featherman and Pavlou, 2003). It is the case that the mobile apps do not always process payments smoothly due to availability, loading speed, responsiveness, and the processing ability of networks and terminals. This may result in inconvenience for a consumer if it takes a long time to process a transaction.

In order to examine which risk dimension is the most salient concern in m-payment acceptance, we propose:

H1. Each risk dimension has a negative influence on perceived value in relation to m-payment.

H2. Each risk dimension has a negative influence on acceptance intention in relation to m-payment.

3.2 Determinants of consumer perceived risk in m-payment acceptance

In this research, uncertainties may result from technology itself, vendor, regulatory environment, and the nature of the service. Thus, perceived uncertainty consists of perceived technological uncertainty, perceived information asymmetry (information

uncertainty), perceived regulatory uncertainty, and perceived service intangibility (description uncertainty).

3.2.1 Perceived information asymmetry. Prior studies indicate that information asymmetry and incomprehensiveness may increase a consumer's perceived risk when buying products or services, especially in the online context (Chen and Chang, 2005; Pavlou *et al.*, 2007). In m-payment, consumers (principals) may also delegate the payment function to mobile financial service providers (agents) according to the principal-agent theory (Akerlof, 1970). Consumers may feel more uncertain information in m-payment due to the complexity of the various participants involved in the service chain. There may also be great information asymmetry between consumers and service providers when an electronic fund transfer is processed automatically via an agent's information system.

Perceived information asymmetry is defined as the consumer's perception that m-payment service providers have an advantage over consumers as they know more about the functions, charging, privacy protection, account security, and so on, of an m-payment service (Pavlou *et al.*, 2007). Consumers have only a very limited surveillance of agent's behavior. The possible hidden actions of m-payment service providers include the abuse of consumer's privacy information, the exposure of account details or passwords, etc., which negatively influence consumer's interests. When consumers believe the existence of the hidden action or hidden information from service providers, they will become unsure about the outcomes of m-payment usage. Thus, their perception of information uncertainties or information asymmetry may result in substantial risk concerns regarding m-payment. Thus, we hypothesize that:

H3. Perceived information asymmetry positively influences each dimension of perceived risk.

3.2.2 Perceived technological uncertainty. Technological uncertainty refers to the unpredictability of technological development, the turbulent technological environment, and uncertainty about the functions and consequences of the technology (Song, 2001). Due to the risk of immature technology, the executive's perceived technological uncertainty has a significant influence on new product development (Song, 2001). Ellis and Shpielberg (2003) indicated that managers just respond to perceived uncertainties but not to unnoticed uncertainties. Thus, it is reasonable to argue that consumer's perceptions of technological uncertainty may also affect their purchase decisions about the products and services, especially for high-tech products. For instance, uncertainty about the technology may result in consumer concerns about its performance.

Perceived technological uncertainty is defined as consumer's perception of the uncertainties in the stability, reliability, and security of m-payment system, and uncertainties in the loading, responsiveness, and connectivity of wireless networks in this paper (Song, 2001; Heavey and Simsek, 2013). Consumer perception of IT security has been regarded as an important part of perceived uncertainty in online exchange context (Pavlou *et al.*, 2007). For m-payment, an important advantage over other payment approaches is its pervasive character. In a wireless environment, consumers will have a strong risk concern if they are unfamiliar with m-payment technology. As the wireless telecom network is more open and vulnerable than a wired network, consumer may not fully understand the technical aspects of the system. Thus, they may perceive strong uncertainties in technology reliabilities, connectivity, and securities, leading to concerns

about possible unfavorable consequences, such as unstable performance and exposure of privacy information. Therefore we propose the following hypothesis:

H4. Perceived technology uncertainties positively influence each perceived risk dimension.

3.2.3 Perceived service intangibility. Generally, services may result in a higher perceived risk level than goods for the special properties including perishability, heterogeneity, inseparability, and intangibility (Mitchell, 1999). The m-payment service is different from traditional services. As mobile technologies allow consumers to store the services information in mobile terminals, be physically separated from service suppliers, and enjoy unified services via a terminal interface. Consequently, the m-payment service does not have the characteristics of perishability, heterogeneity, and inseparability, but it is still intangible.

Perceived service intangibility refers to a consumer's perception of the difficulty in mentally representing, defining, or describing the m-payment (Laroche *et al.*, 2004). The intangibility of service was found to significantly increase perceived risks (Laroche *et al.*, 2004). Prior study found that intangibility has greater impacts on perceived risk in the online context than the offline (Eggert, 2006). It is worth noting that the intangibility of the mobile service substantially differs from traditional intangibility. Information technology makes it possible to observe the performance of the service via terminals, which means that the intangibility is tangibilized (Berthon *et al.*, 1999). In order to examine the influences of perceived service intangibility on perceived risks in m-payment, we hypothesize that:

H5. Perceived service intangibility positively influences each dimension of perceived risk.

3.2.4 Perceived regulatory uncertainty. Engau and Hoffmann (2009) defined regulatory uncertainty as "the unpredictability of governmental agencies which create and enforce regulations" and validated that a firm's perceived regulatory uncertainty significantly affects management decision making. In previous literature, perceived regulatory uncertainty was reported as an influential predictor of management decisions within corporations (Engau and Hoffmann, 2011; Fabrizio, 2013). However, regulatory uncertainty may also have an effect on consumer behavior or interests. In our study, perceived regulatory uncertainty refers to a consumer's perceptions of the instability or uncertainties of the regulatory environment of m-payment.

At present, the regulations on m-payment are far from mature. In fact, the development of m-payment in practice is actually much quicker than legislative development. For instance, the standard for m-payment has not been unified, and the legality of 2D code payment via a smart phone has not been verified in China yet. For the relevant regulations have great impacts on consumer interests, thus uncertainties in the regulatory environment may induce consumer's risk concerns in m-payment. Therefore, it is proposed that:

H6. Perceived regulatory uncertainty positively influences each dimension of perceived risk.

3.3 Perceived value and acceptance intention

Prospect theory suggests that people make decisions based on subjective value, which is consistent with perceived value theory (Kahneman and Tversky, 1979; Wood and

Scheer, 1996). We define perceived value as a consumer's comprehensive evaluation of m-payment based on the perception of the potential benefits and sacrifices induced by m-payment adoption (Kim *et al.*, 2007). Previous studies reported a strong relationship between perceived value and acceptance intention in mobile internet or service adoption (Kim *et al.*, 2007; Kleijnen *et al.*, 2007). Thus, based on both prospect theory and perceived value theory, it is reasonable to assume that perceived value significantly affects consumer acceptance intention in relation to m-payment. Therefore, the following hypothesis is proposed:

H7. Perceived value positively influences consumer acceptance intention in relation to m-payment.

4. Research methodology

4.1 Measurement development

A survey questionnaire was used to collect data. All items measuring the constructs were adapted from extant literature, and slightly modified to fit our research context. Perceived information asymmetry and perceived technological uncertainty were adapted from Pavlou *et al.* (2007), Kim *et al.* (2008), and Song (2001). We borrowed the measures of perceived regulatory uncertainty from Engau and Hoffmann (2009). Perceived service intangibility was measured by items adapted from Laroche *et al.* (2004). The measures associated with perceived risk and its components were adapted from Featherman and Pavlou (2003). The items of perceived value were adapted from Kim and Chan *et al.* (2007). Acceptance intention was adapted from Kim *et al.* (2007). All items were measured by a seven-point Likert scale ranging from extremely disagree (1) to extremely agree (7). The measurement items are shown in the Appendix.

4.2 Data collection

Before the formal survey, we conducted a pilot test with 20 respondents including professionals, users, and some graduates in the field. Thereafter, some items were revised according to their suggestions, which ensured there were no misunderstandings and made the questionnaire easier to understand. We collected data through a professional questionnaire survey web site in China (www.sojump.com), which has over four million subscribers. The IP addresses of the respondents show a high geographic diversity, which covers 26 of the 34 provincial districts in China. We received 310 usable responses over four weeks (January 2013). An incentive of CNY ¥5 was paid for each usable response. The demographics of the samples show that 43.2 percent are female, and 56.8 percent are male; 71.0 percent are between 25 and 35 years old. In terms of education, undergraduates and postgraduates make up 92.2 percent of the respondents. Most respondents (86.1 percent) were company employees, public servants, teachers, etc., while students constitute 13.9 percent. A third of the respondents have experience of m-payment.

4.3 Reliability and validity

The partial least squares (SmartPLS 2.0) approach was adopted to estimate the parameters of SEM, including measurement validation and hypothesis testing (Ringle *et al.*, 2005). Scale reliability was tested through composite reliability (CR) and Cronbach's α. In this study, Cronbach's α and the CR values of all the constructs were higher than 0.7 and 0.8, respectively, which means that the measurement scales have a substantial internal consistency (Fornell and Larcker, 1981). Convergent validity was estimated via average

variance extracted (AVE). As shown in Table I, the values of AVEs were higher than 0.5, indicating that reliability and convergent validity were acceptable (Fornell and Larcker, 1981). We also assessed the discriminative validity by comparing the square root of AVE and the inter-correlation coefficients of constructs. As shown in Table I, the diagonal values are higher than the correlation coefficients for each construct, respectively, which means the discriminative validity is acceptable (Fornell and Larcker, 1981).

4.4 Testing the hypotheses

First, multicollinearity was tested by collinearity statistics via variance inflation factor (VIF). The VIF values of variables ranged from 1.057 to 2.363, suggesting multicollinearity is not a concern in the model (Hair *et al.*, 2014). Then, both path coefficients and R^2 were assessed. The significant path coefficients are depicted in Figure 2. The hypotheses testing showed that perceived value was positively associated with acceptance intention. Thus *H7* was supported. Perceived financial risk and perceived performance risk affect both perceived value and acceptance intention negatively, and perceived privacy risk is also associated negatively with acceptance intention. Therefore, *H1* and *H2* were partly validated.

Furthermore, PIA was found to have a strong positive effect on PFR, PPR, and PPrR. PTU exerts a positive effect on PPrR and PPR. PRU has a positive effect on PPrR and PFR. PSI is only positively associated with PFR. Therefore, *H3*, *H4*, *H5*, and *H6* are all partially supported. The R^2 of PPR, PPrR, and PFR were 0.454, 0.439, and 0.420, respectively, which indicates that the model has a strong variance explanation for PPR, PPrR, and PFR. Additionally, the R^2 of PV and AI were 0.237 and 0.380, respectively, which is also reasonable because it reflects the influence of perceived risk rather than all of the determinants of perceived value and acceptance intention.

5. Discussion and conclusions

5.1 Discussion

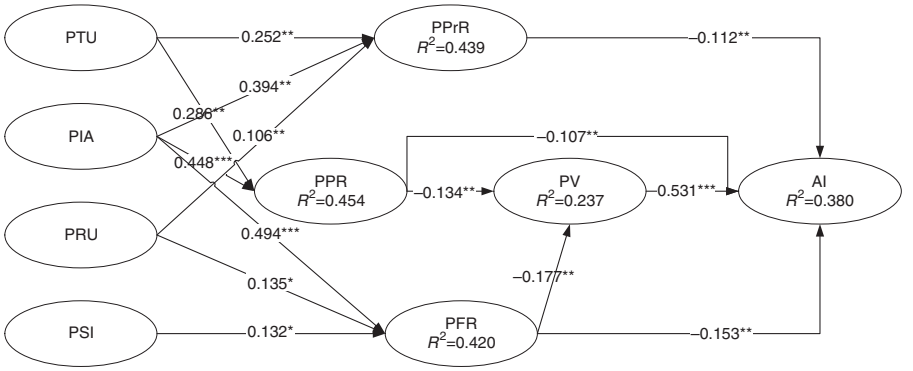
The significant adverse effects of perceived financial risk on perceived value and acceptance intention indicate that financial risk is the strongest negative factor hindering the consumer acceptance of m-payment. In other words, consumers have serious capital security concerns when using m-payment. Perceived performance risk is another negative construct influencing both perceived value and acceptance intention, and has a greater hindering effect on perceived value than behavioral intention. This suggests that consumer concerns about the functions of m-payment substantially lower the perception of the value of m-payment and reduce acceptance intention. Perceived privacy risk has a salient impact on acceptance intention, but no influence on perceived value, which means that when consumers make a decision about whether to adopt m-payment, privacy considerations make a difference, but do not influence their perception of the value of m-payment.

Out of expectations, both perceived psychological risk and perceived time risk were found to have no effect on perceived value and acceptance intention. The findings indicate that consumers have a positive attitude about m-payment, and do not think a mobile service will lead to any psychological discomfort. In addition, consumers believe that although there might be time risk in m-payment, any time consumed would be matched by the benefits they achieve from m-payment. Therefore, time consumption does not weaken consumer perception of the value of m-payment and their usage intention.

Table I.
Reliability and validity

Factor	AVE	CR	α	AI	PSI	PRU	PFR	PIA	PPR	PPrR	PPsR	PTR	PTU	PV
AI	0.914	0.970	0.953	*0.956*										
PSI	0.859	0.961	0.945	−0.104	*0.927*									
PRU	0.875	0.955	0.929	−0.115	0.211	*0.936*								
PFR	0.870	0.964	0.950	−0.326	0.374	0.447	*0.933*							
PIA	0.844	0.956	0.938	−0.195	0.433	0.574	0.629	*0.919*						
PPR	0.802	0.942	0.918	−0.254	0.492	0.472	0.636	0.639	*0.896*					
PPrR	0.888	0.969	0.958	−0.262	0.344	0.470	0.623	0.623	0.639	*0.942*				
PPsR	0.871	0.953	0.926	−0.125	0.418	0.355	0.490	0.528	0.595	0.585	*0.933*			
PTR	0.725	0.910	0.864	−0.156	0.339	0.306	0.328	0.391	0.517	0.449	0.539	*0.852*		
PTU	0.774	0.932	0.902	−0.242	0.386	0.548	0.478	0.668	0.584	0.574	0.524	0.416	*0.880*	
PV	0.812	0.945	0.923	0.580	−0.181	−0.015	−0.223	−0.190	−0.179	−0.162	−0.097	−0.073	−0.122	*0.901*

Note: The square roots of AVE are on the diagonal



Note: *,**,***Significant at $p<0.05$, 0.01 and 0.001 levels, respectively

Figure 2.
Hypotheses testing results

The empirical test results on the determinants of the dimensions of perceived risk show that perceived information asymmetry exerts greater effects on sub-dimension risks than other predictors, which suggests that information asymmetry is the most important source of perceived risks, especially perceived financial risk in m-payment.

The second salient determinant of perceived risk is perceived technological uncertainty, which is seen as another source of perceived privacy risk and perceived performance risk. This finding indicates that though m-payment has various benefits, users are not sure about the reliability and security of the advanced technologies involved in m-payment, which leads to their concerns about the privacy and the performance of m-payment.

Additionally, the intangibility of the m-payment service was found to only have an impact on perceived financial risk, which is not consistent with the works of Laroche *et al.* (2004) and Eggert (2006), in which intangibility was found to exert influences on nearly all risk dimensions. A possible explanation is that the effect of the intangibility of m-payment services has been somewhat tangibilized by terminal screens (Berthon *et al.* (1999). However, although consumers can see and experience the service via mobile terminals, the results show that they are not sure about the certificate of transferring funds or the control of the capital.

Furthermore, consumer perception about the comprehensiveness and stability of the relevant regulations and standards also leads to concerns about privacy and capital security because if the right to privacy is violated and financial losses occur as a result, a successful claim for compensation will depend on sound regulations.

5.2 Implications

5.2.1 Theoretical implications. The primary theoretical contribution of this paper is the identification of the significant determinants of perceived risk in m-payment based on the qualitative analysis of the sources of perceived risk suggested by Mitchell (1999), Lim (2003), and Conchar *et al.* (2004).

Four categories of uncertainties were validated as the determinants of perceived risk in the m-payment context. Prior studies mainly examined the reducing effects of some antecedents on perceived risk, such as service quality cues (Chen and Chang, 2005), privacy and security protection, reputation, third-party presence (Kim *et al.*, 2008), web

site quality (Kim and Lennon, 2013), and trust and customer loyalty (Mann and Sahni, 2013). This paper makes a difference by presenting the sources of perceived risk from an uncertainty perspective to understand how the perceived risks in m-payment are formulated.

This paper also extended the work of Laroche *et al.* (2004) by confirming three other determinants of perceived risk in addition to intangibility. The findings offer a more comprehensive explanation of the sources of perceived risk regarding m-payment.

In addition, the study is among the first to explore the effect of perceived technological uncertainty and perceived regulatory uncertainty on consumer acceptance behavior. These two constructs were previously only explored in the context of executive decision-making within corporations. Our findings suggest that the two constructs have strong negative influences on consumer behavior.

Additionally, this study provides a different perspective on perceived risk in perceived value theory model. We examined the effects of different risk dimensions on perceived value and acceptance intentions, and then confirmed the antecedents of the significant risk dimensions, bridging the gap between the antecedents and consequences of perceived risk.

5.2.2 Practical implications. The research also provides a number of managerial implications. Regarding the strong adverse impact of perceived risk on m-payment acceptance, effective strategies should be developed to relieve consumer risk concerns about m-payment in order to promote the adoption of the technology.

In this research, perceived information asymmetry was found to be the strongest predictor of perceived risk in m-payment. The finding implies that for m-payment service providers, it is necessary to improve information transparency, such as offering more information about charging, privacy protection, account security, technology security, etc. First, the charging policies for the m-payment services should be specified clearly and be easy for consumers to understand, avoiding ambiguous explanations. The introduction to an m-payment service should be based on a subscriber's full understanding, knowledge, and permission, but should not open automatically without permission from the consumer in question. Charging information should be reported to subscribers regularly and should be accompanied by a detailed breakdown of the charging. In particular, a subscriber should be alerted of unusual charging and confirmed immediately in order to avoid abnormal losses. Second, the privacy protection policy and claim procedure should also be explicit. For example, information about consumer consumption habits and shopping records should be protected and not made public or maliciously used. Third, service operators should provide not only security protection measures for accounts, but also some remedy and warranty policies.

As proved above, perceived technological uncertainty is another source of perceived risk. Thus, it is imperative for m-payment service providers to make a detailed explanation about the security and performance of the technologies used in m-payment. Although developers have confidence in their technology, consumer may not be so sure about it due to their unfamiliarity with the advanced technology. Therefore, it is necessary for developers to take some measures to ease their concerns about the reliability, connectivity, and security of the technologies. In addition to the free trial of the service, developers could insure for any capital loss resulting from imperfect technology. This would be an effective way to introduce a

third party to insure the risk of losing money due to technology defects. For example, Alipay wallet insures against monetary losses that customers may incur as a result of a breach of their payment system security.

The results suggest that regulatory uncertainty about m-payment significantly increases consumer's privacy and financial concerns. The regulation deficiencies of privacy protection in mobile commerce make it difficult for consumer to claim for rights. In addition, the lack of unified standards for m-payment may have created the opportunity for ineligible companies to provide the services. There is an urgent need for more thorough regulations in the m-payment industry, such as the legality of mobile transactions, approval requirements for the eligibility of the third-party m-payment platform, relative standards for the technology and service, punishments for the malicious or unintended violation of consumer privacy, and so on. Additionally, service providers should convince consumers that these regulations are in effect.

Finally, perceived service intangibility is reported as another predictor of perceived risk. Therefore, some measures should be developed to lower the intangibility of m-payment. In the m-payment context, some transaction proofs could be stored in terminals, thus the main concerns result from consumer's inability to describe or grasp the service (Laroche *et al.*, 2004). Therefore, on the one hand, the legality of key proofs in mobile transactions should be verified as soon as possible by relevant policy makers, and the proofs must be controllable by the consumer. On the other hand, it is also imperative for developers to educate consumers about knowledge, operation skills, and inform consumers about possible bugs in relation to m-payment and help establish a positive conception and image for m-payment. These efforts may substantially improve consumer's understanding of the m-payment services and reduce perceived risk by reducing perceived intangibility.

5.3 Conclusions

In the study, an uncertainty-risk-value framework was proposed and empirically tested. We quantified the effects of each risk dimension as well as their antecedents in m-payment acceptance, which provides the basis for understanding the sources of perceived risks and the influence of perceived risks on m-payment acceptance. Perceived financial risk, privacy risk, and performance risk were found to have salient impacts on the perceived value and acceptance intention of consumers. The important determinants of perceived risk were verified, including perceived information asymmetry, perceived technological uncertainty, perceived regulatory uncertainty, and perceived service intangibility.

This research also has some limitations. The theoretical basis of our research framework is derived from theories rooted in different research fields and the significant results reported in the study, to a large extent, the four uncertainty dimensions should be important antecedents across different contexts. However, the generalization of the results should be made cautiously because the degree of the interdependencies and validity may vary according to different cultural or service contexts.

This study examined how perceived risk affects m-payment acceptance from the perceptive of individual consumers, thus future studies could research how perceived risk affects m-payment acceptance from the organizational perspective.

References

Akerlof, G. (1970), "The market for lemons: quality uncertainty and the market mechanism", *Quarterly Journal of Economics*, Vol. 84 No. 3, pp. 488-500.

Bauer, R.A. (1960), "Consumer behavior as risk taking", in Hancock, R.S. (Ed.), *The 43rd Conference of the American Marketing Association*, American Marketing Association, Chicago, IL, pp. 389-398.

Berthon, P., Pitt, L., Katsikeas, C.S. and Berthon, J.P. (1999), "Executive insights: virtual services go international services in the marketplace", *Journal of International Marketing*, Vol. 7 No. 3, pp. 84-105.

Chandra, S., Srivastava, S.C. and Theng, Y. (2010), "Evaluating the role of trust in consumer adoption of mobile payment systems: an empirical analysis", *Communications of the Association for Information Systems*, Vol. 27 No. 10, pp. 561-588.

Chen, T. and Chang, H. (2005), "Reducing consumers' perceived risk through banking service quality cues in Taiwan", *Journal of Business and Psychology*, Vol. 19 No. 4, pp. 521-540.

Chiu, C., Wang, E.T.G., Fang, Y. and Huang, H. (2014), "Understanding customers' repeat purchase intentions in B2C e-commerce: the roles of utilitarian value, hedonic value and perceived risk", *Information Systems Journal*, Vol. 24 No. 1, pp. 85-114.

Conchar, M.P., Zinkhan, G.M., Peters, C. and Olavarrieta, S. (2004), "An integrated framework for the conceptualization of consumers' perceived-risk processing", *Journal of the Academy of Marketing Science*, Vol. 32 No. 4, pp. 418-436.

Constantiou, I.D. (2009), "Consumer behaviour in the mobile telecommunications' market: the individual's adoption decision of innovative services", *Telematics and Informatics*, Vol. 26 No. 3, pp. 270-281.

Cox, D.F. and Rich, D.F. (1964), "Perceived risk and consumer decision making-the case of telephone shopping", *Journal of Marketing Research*, Vol. 1 No. 4, pp. 32-39.

Dodds, W.B. and Monroe, K.B. (1985), "The effect of brand and price information on subjective product evaluations", *Advances in Consumer Research*, Vol. 12 No. 1, pp. 85-90.

Eggert, A. (2006), "Intangibility and perceived risk in online environment", *Joumal of Marketing Managetnent*, Vol. 22 Nos 5-6, pp. 553-572.

Ellis, S. and Shpielberg, N. (2003), "Organizational learning mechanisms and managers' perceived uncertainty", *Human Relations*, Vol. 10 No. 56, pp. 1233-1254.

Engau, C. and Hoffmann, V.H. (2009), "Effects of regulatory uncertainty on corporate strategy-an analysis of firms' responses to uncertainty about post-Kyoto policy", *Environmental Science & Policy*, Vol. 12 No. 7, pp. 766-777.

Engau, C. and Hoffmann, V.H. (2011), "Strategizing in an unpredictable climate: exploring corporate strategies to cope with regulatory uncertainty", *Long Range Planning*, Vol. 44 No. 1, pp. 42-63.

Fabrizio, K.R. (2013), "The effect of regulatory uncertainty on investment: evidence from renewable energy generatst", *Journal of Law, Economics & Organization*, Vol. 29 No. 4, pp. 765-798.

Featherman, M.S. and Pavlou, P.A. (2003), "Predicting e-services adoption: a perceived risk facts perceptive", *International Journal of Human–Computer Studies*, Vol. 59 No. 4, pp. 451-474.

Fornell, C. and Larcker, D.F. (1981), "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, Vol. 18 No. 1, pp. 39-50.

Forsythe, S.M. and Shi, B. (2003), "Consumer patronage and risk perceptions in internet shopping", *Journal of Business Research*, Vol. 56 No. 11, pp. 867-875.

Hair, J.F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M. (2014), *A Primer on Partical Least Squares Structural Equation Modeling (PLS-SEM)*, SAGE Publication, Thousand Oaks, CA.

Heavey, C. and Simsek, Z. (2013), "Top management compositional effects on corporate entrepreneurship: the moderating role of perceived technological uncertainty", *Journal of Product Innovation Management*, Vol. 30 No. 5, pp. 837-855.

Kahneman, D. and Tversky, A. (1979), "Prospect theory: an analysis of decisions under risk", *Econometrica*, Vol. 47 No. 2, pp. 313-327.

Kim, C., Mirusmonov, M. and Lee, I. (2010), "An empirical examination of factors influencing the intention to use mobile payment", *Computers in Human Behavior*, Vol. 26 No. 3, pp. 310-322.

Kim, D.J., Ferrin, D.L. and Rao, H.R. (2008), "A trust-based consumer decision-making model in electronic commerce: the role of trust, perceived risk, and their antecedents", *Decision Support Systems*, Vol. 44 No. 2, pp. 544-564.

Kim, H., Chan, H.C. and Gupta, S. (2007), "Value-based adoption of mobile internet: an empirical investigation", *Decision Support Systems*, Vol. 43 No. 1, pp. 111-126.

Kim, J. and Lennon, S.J. (2013), "Effects of reputation and website quality on online consumers' emotion, perceived risk and purchase intention: based on the stimulus-organism-response model", *Journal of Research in Interactive Marketing*, Vol. 7 No. 1, pp. 33-56.

Kleijnen, M., de Ruyter, K. and Wetzels, M. (2007), "An assessment of value creation in mobile service delivery and the moderating role of time consciousness", *Journal of Retailing*, Vol. 83 No. 1, pp. 33-46.

Laroche, M., McDougall, G.H.G., Bergeron, J. and Yang, Z. (2004), "Exploring how intangibility affects perceived risk", *Journal of Service Research*, Vol. 6 No. 4, pp. 373-389.

Li, Z. and Bai, X. (2010), "Influences of Perceived Risk and System Usability on the Adoption of Mobile Banking", *Proceedings of the Third International Symposium on Computer Science and Computational Technology*, *14-15 August, Jiaozuo*, pp. 51-54.

Lim, N. (2003), "Consumers' perceived risk: sources versus consequences", *Electronic Commerce Research and Applications*, Vol. 2 No. 3, pp. 216-228.

Mann, B.J.S. and Sahni, S.K. (2013), "Role of trust and customer loyalty in reducing perceived security risk in internet banking", *International Journal of Electronic Business*, Vol. 10 No. 4, pp. 331-354.

Martins, C., Oliveira, T. and Popovič, A. (2014), "Understanding the Internet banking adoption: a unified theory of acceptance and use of technology and perceived risk application", *International Journal of Information Management*, Vol. 34 No. 1, pp. 1-13.

MIIT (2014), *Monthly Economy Development Report of Telecommunication Industry of China (January 2014)*, Ministry of Industry and Information Technology of China, Beijing.

Mitchell, V.W. (1999), "Consumer perceived risk: conceptualization and models", *European Journal of Marketing*, Vol. 33 Nos 1/2, pp. 163-195.

Pavlou, P.A., Liang, H. and Xue, Y. (2007), "Understanding and mitigating uncertainty in online exchange relationships, a principal-agent perspective", *MIS Quarterly*, Vol. 31 No. 1, pp. 105-136.

Ringle, C.M., Wende, S. and Will, A. (2005), SmartPLS 2.0 (beta), Hamburg, available at: www.smartpls.de

Schierz, P.G., Schilke, O. and Wirtz, B.W. (2010), "Understanding consumer acceptance of mobile payment services: an empirical analysis", *Electronic Commerce Research and Applications Special Issue: Nomadic and Mobile Computing*, Vol. 9 No. 3, pp. 209-216.

Song, M. (2001), "The effect of perceived technologyical uncertainty on Japanese new product development", *Academy of Management Journal*, Vol. 44 No. 1, pp. 61-80.

Wood, C.M. and Scheer, L.K. (1996), "Incorporating perceived risk into models of consumer deal assessment and purchase intent", *Advances in Consumer Research*, Vol. 23 No. 1, pp. 399-404.

Zeithaml, V.A. (1988), "Consumer perceptions of price, quality, and value: a means-end model and synthesis of evidence", *Journal of Marketing*, Vol. 52 No. 3, pp. 2-22.

Appendix. Measurement items for the constructs

PIA

Service providers have more information about the charging, security, service quality, and transaction processes.

Some operations about checking account are unknown to me.

Information security protection measures are not clear to me.

I am not sure that service providers execute the measures and policies as they said.

PTU

The wireless network of m-payment is not stable.

The security of transaction information is questionable.

The technology systems of m-payments are undeveloped.

Transaction information could be destroyed, intercepted, or revised during transactions.

PRU

The regulations about user rights regarding m-payment are incomplete.

The regulations for the m-payment industry are insufficient.

The outcomes for claiming compensation are uncertain.

PSI

It is difficult to explain the features of m-payment.

It is difficult to describe how it works.

M-payment is difficult to think about.

M-payment is abstract.

Perceived risk dimensions

PFR

The use of m-payment would cause the exposure of capital accounts and passwords.

Malicious and unreasonable charging occurs.

A careless operation could lead to a surprising loss.

The use of m-payment can cause financial risk.

PPrR

Privacy information could be misused, inappropriately shared, or sold.

Personal information could be intercepted or accessed.

Payment information could be collected, tracked, and analyzed.

Privacy could be exposed or accessed when using m-payment.

PPR

The payment system may be unstable or blocked.

It does not work as expected.

The performance level may be lower than designed.

The service performance may not match its advertised level.

PPsR

It would cause unnecessary tension, e.g., concerns about errors in operation.

A breakdown in m-payment could cause unwanted anxiety and confusion.

The usage of m-payment could cause discomfort.

PTR

Time loss could be caused by instability and low speed.

It may take too much time to learn how to use it.

More time is required to fix payment errors offline.
Using m-payment may waste time.
PV
Considering the cost, risk, and benefits, I think it is valuable.
Despite the time, effort, and capital involved in m-payment, it is worthwhile to me.
There are greater benefits than disadvantages of using m-payment.
Overall, it delivers value.
AI
I intend to use m-payment in the future.
I expect to adopt m-payment soon.
I am willing to use m-payment in the future.

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1. Minkyung Choy, Gunno Park. 2016. Sustaining Innovative Success: A Case Study on Consumer-Centric Innovation in the ICT Industry. *Sustainability* **8**:10, 986. [CrossRef]
2. Chin-Lung Hsu, Judy Chuan-Chuan Lin. 2016. Exploring Factors Affecting the Adoption of Internet of Things Services. *Journal of Computer Information Systems* 1-9. [CrossRef]
3. Torsten J. Gerpott, Phil Meinert. 2016. Correlates of using the billing system of a mobile network operator to pay for digital goods and services. *Information Systems Frontiers* . [CrossRef]
4. June Lu, June Wei, Chun-sheng Yu, Chang Liu. 2016. How do post-usage factors and espoused cultural values impact mobile payment continuation?. *Behaviour & Information Technology* 1-25. [CrossRef]
5. Tiago Oliveira, Manoj Thomas, Goncalo Baptista, Filipe Campos. 2016. Mobile payment: Understanding the determinants of customer adoption and intention to recommend the technology. *Computers in Human Behavior* **61**, 404-414. [CrossRef]
6. Gwarlann de Kerviler, Nathalie T.M. Demoulin, Pietro Zidda. 2016. Adoption of in-store mobile payment: Are perceived risk and convenience the only drivers?. *Journal of Retailing and Consumer Services* **31**, 334-344. [CrossRef]
7. Hun Choi, Yoo-jung Choi. 2016. The Impact Perceived Risk on User's Trust and Continuance Intention in Mobile Payment Systems. *Journal of the Korea Institute of Information and Communication Engineering* **20**:6, 1096-1102. [CrossRef]
8. TanEvon Evon Tan Evon Tan is based in Cheras, Malaysia. Leby LauJasmine Jasmine Leby Lau Jasmine Leby Lau is based in Seri Kembangan, Malaysia. Cheras, Malaysia Seri Kembangan, Malaysia . 2016. Behavioural intention to adopt mobile banking among the millennial generation. *Young Consumers* **17**:1, 18-31. [Abstract] [Full Text] [PDF]
9. Zakaria Sahnoune, Esma Aimeur, Ghada El Haddad, Rodrigue SokoudjouWatch Your Mobile Payment: An Empirical Study of Privacy Disclosure 934-941. [CrossRef]