INVESTIGATING FACTORS INFLUENCING ADOPTION OF MOBILE PAYMENT

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ABSTRACT

In recent years, mobile payment has emerged as a new payment method transcending both the temporal and spatial constraints. However, the adoption of mobile payment has been slow. Mobile payment refers to the use of mobile devices to initiate, authorize, and confirm payment transactions (Au & Kauffman, 2008). Drawing on the traditional technology adoption theories and more recent research on mobile payment adoption, this paper develops a research model to explore important factors underlying users' intention to adopt mobile payment. The model focuses on the effects of perceptions of mobile payment characteristics (perceived relative advantages, perceived effort expectancy, perceived compatibility, and perceived risks of mobile payment), characteristics of mobile payment use context (time criticality and spatial criticality of access to payment service), subjective norm concerning mobile payment usage, and individual characteristic of potential users (individual mobility). An online survey study was conducted to test the research model and its associated hypotheses. The survey results suggest that the individual mobility of potential users, the perceived compatibility and risks of mobile payment, and the characteristics of mobile payment use context are significant predictors of the intention to adopt mobile payment.

Keywords: mobile payment adoption, perceived characteristics of mobile payment, characteristics of use contexts, individual mobility

INTRODUCTION

In recent years, mobile payment has emerged as a potential new payment method transcending both the temporal and spatial constraints. The mobile technology innovations allow consumers to make payments via mobile devices at anytime and from anywhere without the limitations of time and space. Mobile payment is defined as the use of mobile devices to initiate, authorize, and confirm payment transactions (Au & Kauffman, 2008). Mobile payment is a key component of but not limited to the practice of mobile commerce. It not only can be used for remote payment transactions such as e-commerce, but it can also be used for proximity payment applications such as payment at point of sales (e.g., vending machine, ticketing kiosks, etc.) (Chandra, Srivastava, & Theng, 2010). Despite the ubiquity of mobile devices and the potential benefits of mobile payment technology, the adoption of mobile payment has been slow (Chandra et al., 2010). The adoption rate of mobile payment has emphasized the need for more substantive research to provide a better understanding of user acceptance and adoption of mobile payment. The focus of this paper is to examine user adoption of mobile payment by identifying important issues and determinants of mobile payment adoption.

Mobile Payment

Mobile payment is a small piece of a much bigger puzzle. It has been defined as "that type of payment transaction processing in the course of which - within an electronic procedure - (at least) the payer employs mobile communication techniques in conjunction with mobile devices for initiation, authorization or realization of payment" (Pousttchi, 2003). Once the payment is initiated, several payment procedures are then identical regardless of how the payment was started. However, the beginning and end of the transaction is through a mobile device. This change has created several opportunities for businesses because it opens the door for mobile commerce, which involves the completing a sale via a wireless device without time or space limitations (Au & Kauffman, 2008; Mallat, 2007). However, just because the technology exists does not mean that users will automatically adopt the new models.

Mobile Payment Environment

A significant portion of the mobile devices market is the smart phone. Smart phones accounted for over 50% of the mobile phone market in 2012 and over 64% in 2015 (Scott, 2012; Smith, 2015). While the growth in the use of smart phones (opposed to tablets and other devices) may not be fully responsible for the volume of mobile payment functions, the adoption rate of smart phones should be recognized as the strong contributor influencing mobile payment growth. Consumers are adapting to smart phone uses, but the focus seems to be centered on other applications opposed to the activity of mobile payment. As highlighted in the digital consumer report smart phone users access their social media sites over 45% each day, 44% shop and browse product purchases (mobile shopping less mobile payment), and 66% surfing for various information (U.S. Digital Consumer Report, 2014). Supporting the modest rate of user adoption of mobile payment is the 2015 survey report that reported 75% of respondents found using cash or card for transactions easier, with 59% stated that they saw no benefit to using mobile payment (Stewart, 2015). Reardon (2012) from CNET suggested that the infrastructure of mobile payments today "seemed more like a novelty than a necessity". In contrast the availability of mobile payment has exploded since the introduction of Apply Pay in the fall of 2014, yet Apple Pay had reported only 13% usage and a projection of an addition 11% for 2015. (Electronic Verification Systems, 2015; Borison, 2015). Potential users of mobile payment may well be conflicted by the benefits of speed and convenience against security and privacy issues associated with mobile payment.

LITERATURE REVIEW AND THEORETICAL BACKGROUND

In the IS research field, a number of theories and research models have been developed or applied to predict and explain acceptance and adoption of information technology innovations. The most prominent theories include the Diffusion of Innovations Theory (DIT) (Rogers, 1995), Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975), Technology Acceptance Model (TAM) (Davis, 1989), and Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003).

DIT postulates five characteristics of innovation as important determinants of innovation diffusion (Rogers, 1995). These are identified as relative advantage, compatibility, complexity, trialability, and observability. Relative advantage is the degree to which an innovation is perceived to be better

than other alternatives (Rogers, 1995). Complexity refers to the degree to which an innovation is perceived as being complex and difficult to use or understand (Rogers, 1995). Compatibility is the degree to which an innovation is perceived as compatible with the existing practices, values, and experiences of potential users (Rogers, 1995). Trialability is the degree to which an innovation can be tried on a limited basis before adoption (Rogers, 1995). Observability refers to the degree to which an innovation provides observable results to potential users (Rogers, 1995). The innovation characteristics of complexity, relative advantage and compatibility have been consistently supported to be significant predictors of information technology adoption behavior (Moore & Benbasat, 1991; Tornatzky & Klein, 1982).

TRA is a general theory that attempts to explain any human behavior from the perspective of social psychology. TRA suggests that a person's certain behavior is determined by his/her behavioral intention to perform the behavior, which in turn is jointly determined by the person's attitude and subjective norm concerning the behavior (Fishbein & Ajzen, 1975). One limitation of TRA is its inadequacy in predicting intentions and behaviors (Armitage & Conner, 2001; Sheeran & Orbell, 1998; Sheeran & Taylor, 1999; Werner, 2004). A set of meta-analyses found that TRA could explain only 33%-50% of the variance in intentions and 19%-38% of the variance in behaviors (Ajzen, 1991; Armitage & Conner, 2001; Sheeran & Orbell, 1998; Sheeran & Taylor, 1999). A number of researchers have identified additional variables (e.g., past behavior and habits, self-identity, affect, anticipated regret, social relations, and etc.) that could increase the predictive ability of TRA (Conner & Armitage, 1998; Landridge, Sheeran, & Connolly, 2007; Rhodes & Courneya, 2003; Sheeran & Orbell, 1998).

TAM builds on and extends TRA to explain user's adoption behavior of information technology (Davis, 1989). According to TAM, a user's intention to adopt a technology is determined by two salient beliefs about the technology – perceived usefulness and perceived ease of use (Davis, 1989). Perceived usefulness is the extent to which a user believes that using the technology will improve his/her job performance, and perceived ease of use refers to the extent to which a user believes that using the technology will be free of effort (Davis, 1989). Both perceived usefulness and perceived ease of use have been found to directly influence technology adoption intention (Davis, 1989).

UTAUT extends TAM by proposing four factors – performance expectancy, effort expectancy, social influence, and facilitating conditions – as determinants of technology adoption intention and behavior (Venkatesh et al., 2003). In addition, a set of moderating factors (i.e. gender, age, experience, and voluntariness of use) are posited to moderate the influences of the four key factors on adoption intention and behavior (Venkatesh et al., 2003). Similar to TAM's perceived usefulness, performance expectancy is the degree to which a person believes that using the technology will help him/her to enhance job performance (Venkatesh et al., 2003). Effort expectancy, like perceived ease of use in TAM, refers to the degree of ease related to the use of the technology (Venkatesh et al., 2003).

A number of studies have utilized DIT, TRA, TAM, and UTAUT to explore the factors influencing user adoption of mobile payment (Chandra et al., 2010; Kim, Mirusmonov, & Lee, 2010; Mallat, Rossi, Tuunainen, & Öörni, 2009; Schierz, Schilke, & Wirtz, 2010; Yang, Lu, Gupta, Cao, & Zhang, 2012). Besides the existing factors in DIT, TRA, TAM, and UTAUT, these studies have enhanced our understanding of mobile payment adoption intention and behavior by identifying

additional factors specifically pertaining to mobile payment technology, including perceptions of mobile payment characteristics (e.g., perceived mobility, reachability, convenience, costs, risks, security, structural assurance, and network externalities), individual characteristics of potential users (e.g., individual innovativeness, individual mobility, and individual knowledge about mobile payment), perceived characteristics of mobile payment providers (e.g., perceived reputation and perceived opportunism of technology providers), and use contexts of mobile payment (e.g., lack of cash or no service personnel in a service location) (Chandra et al., 2010; Kim et al., 2010; Mallat et al., 2009; Schierz et al., 2010; Slade, Williams, & Dwivedi, 2013; Yang et al., 2012). These studies provide a set of potentially relevant factors influencing user adoption of mobile payment. However, there is a lack of understanding of the relative importance and interactions of different factors in predicting mobile payment adoption (Schierz et al., 2010). More empirical research is required to provide a deeper understanding of the dynamics of mobile payment adoption.

RESEARCH MODEL AND HYPOTHESES

Drawing on the traditional technology acceptance and adoption theories and more recent research on mobile payment adoption, this paper develops a research model of key factors influencing user intention to adopt mobile payment (Figure 1). This model focuses on the effects of perceptions of mobile payment characteristics (perceived relative advantages, perceived effort expectancy, perceived compatibility, and perceived risks of mobile payment), characteristics of mobile payment use context (time criticality and spatial criticality of access to payment service), subjective norm concerning mobile payment usage, and individual characteristic of potential users (individual mobility).

Prior research suggests the perceived characteristics of technology innovation play a significant role in technology adoption and diffusion (Davis, 1989; Fishbein & Ajzen, 1975; Rogers, 1995; Venkatesh et al., 2003). The perception of relative advantages offered by a new technology has been found to determine the technology adoption (Rogers, 1995; Venkatesh et al., 2003). In order for a new technology to be widely adopted, the technology has to be perceived to offer advantages relative to the existing comparable technologies it intends to replace. This is especially true for mobile payment, whose success largely depends on its additional benefits and values compared with traditional payment methods, such as ubiquitous access to payment service without time and spatial limitations, timely payment, convenience, and queue avoidance (Mallat et al., 2009). Therefore, the following hypothesis is proposed.

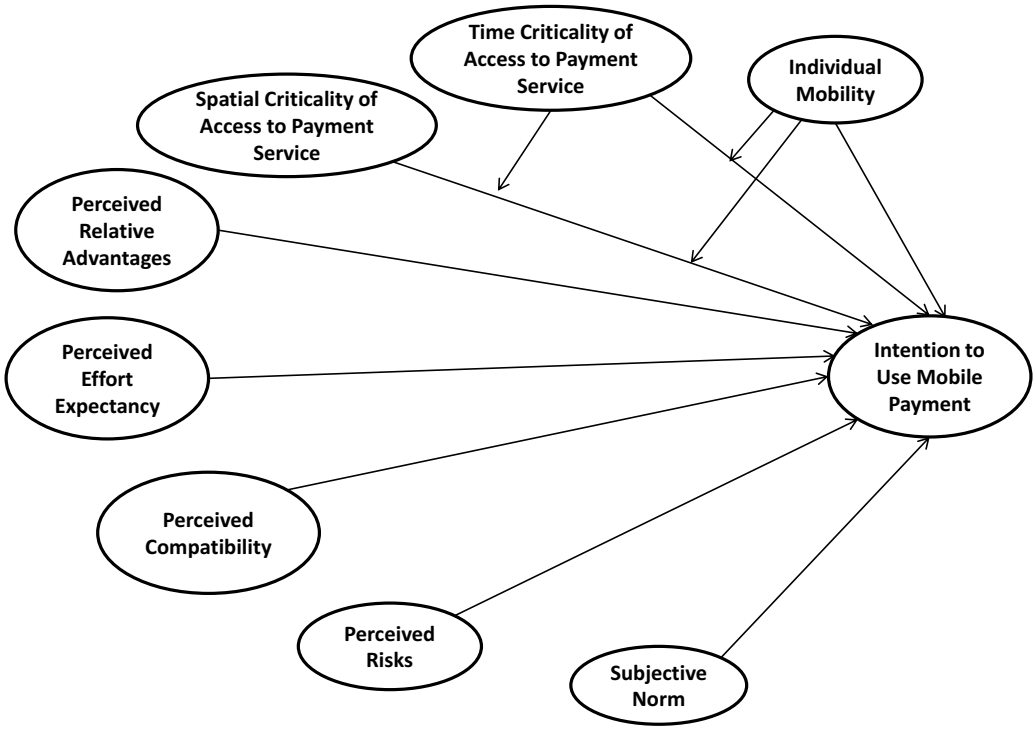
> *Hypothesis 1: Perceived relative advantages of mobile payment will have a positive effect on the intention to use mobile payment.*

Another important determinant of new technology adoption is perceived effort expectancy of technology, which refers to the amount of effort required in using the technology (Venkatesh et al., 2003). It reflects the degree of ease associated with the use of the technology (Venkatesh et al., 2003) and embodies the concepts of perceived ease of use in TAM (Davis, 1989) and perceived complexity in DIT (Rogers, 1995). Perceived effort expectancy is especially critical during the initial stage of mobile payment adoption, when the complexity of initial setup and difficult-to-use small displays and keypads may significantly increase the perception of required effort and diminish the intention to use mobile payment. It is reasonable to expect that the higher the effort

required in using mobile payment, the lower the intention to adopt mobile payment; and vice versa. Thus a second hypothesis is proposed.

> *Hypothesis 2: Perceived effort expectancy of mobile payment will have a negative effect on the intention to use mobile payment.*

Figure 1. Research Model of Key Factors Influencing User Intention to Adopt Mobile Payment



The perceived compatibility of a new technology has also been established as a significant factor influencing the intention to adopt the technology (Karahanna, Agarwal, & Angst, 2006; Rogers, 1995). The perceived compatibility focuses on the fit between a new technology and users' existing practices, values and experiences. In the case of mobile payment, whether it is congruent with users' payment habits and preferences determines the likelihood of its being adopted and integrated into users' daily lives (Kim et al., 2010; Mallat et al., 2009; Yang et al., 2012). This suggests the following hypothesis.

> *Hypothesis 3: Perceived compatibility of mobile payment will have a positive effect on the intention to use mobile payment.*

Due to the potential financial loss associated making a mobile payment, researchers have also recognized the perceived risks of mobile payment as a critical factor inhibiting mobile payment adoption (Mallat et al., 2009; Schierz et al., 2010; Yang et al., 2012). The perceived risks stem from users' concerns on network security, data confidentiality, transaction errors, and service reliability of mobile payment. Therefore, the following hypothesis is suggested.

Hypothesis 4: Perceived risks of mobile payment will have a negative effect on the intention to use mobile payment.

In addition to the perceptions of technology characteristics, social influence also plays an important role in determining technology adoption (Fishbein & Ajzen, 1975; Venkatesh et al., 2003). As the most important construct of social influence in the traditional technology adoption theories, subjective norm refers to user's perception that other people who are important to him/her think he/she should use the technology (Fishbein & Ajzen, 1975; Venkatesh et al., 2003). The effect of subjective norm is especially important during the early stage of new technology adoption when most users lack enough information or knowledge of the technology (Venkatesh et al., 2003). The important role of subjective norm has also been supported in the studies of mobile payment adoption (Schierz et al., 2010; Yang et al., 2012). This suggests the following hypothesis.

Hypothesis 5: The subjective norm concerning mobile payment usage will have a positive effect on the intention to use mobile payment.

More recent research on mobile services in general and mobile payment in specific has highlighted the significance of use context in determining the adoption intention and behavior (Heinonen & Pura, 2006; Mallat et al., 2009; Mallat, 2007; Van der Hejden, 2005). It has been found that users tend to use mobile payment only in certain use situations, such as presence of queues, time pressure, and lack of other payment alternatives (Mallat, 2007). Mobile payment seems to be most preferred in situations where time and/or location are critical for access to payment service (Heinonen & Pura, 2006). By providing ubiquitous access to payment service independent of time and location, mobile payment is considered especially valuable in urgent situations where payments must be made at a specific time and/or a specific location on the move (Heinonen & Pura, 2006). Therefore, it is reasonable to expect that high time or spatial criticality of access to payment service will increase the intention to use mobile payment. In addition, in the situations with high time criticality where the access to payment service is urgently needed, individuals are likely to use mobile payment instantly regardless of location, no matter whether location is critical for the access to payment service. Thus, the positive effect of the spatial criticality of access to payment service on the adoption intention will become weaker when the access to payment service is highly time-critical. So, the time criticality of access to payment service negatively moderates the effect of the spatial criticality of access to payment service on the intention to use mobile payment. Thus, the following three hypotheses are proposed.

Hypothesis 6: The spatial criticality of access to payment service will have a positive effect on the intention to use mobile payment.

Hypothesis 7: The time criticality of access to payment service will have a positive effect on the intention to use mobile payment.

Hypothesis 8: The increased time criticality of access to payment service will weaken the effect of the spatial criticality of access to payment service on the intention to use mobile payment.

The individual characteristics of technology users, such as individual experience, knowledge, training, and etc., have also been found to significantly influence the intention to adopt technology (Kim et al., 2010; Rogers, 1995; Venkatesh et al., 2003; Yang et al., 2012). Individual mobility is the degree to which an individual leads a mobile lifestyle (Schierz et al., 2010) and reflects the individual's past behavior and habit with regard to the usage of mobile applications. Since past behavior has been identified as a useful variable that could predict current or future behavior (Conner & Armitage, 1998; Rhodes & Courneya, 2003), individual mobility may determine the individual's current or future adoption behavior of mobile payment (Schierz et al., 2010). Prior research has provided empirical evidence that individual mobility positively influences mobile payment adoption (Schierz et al., 2010). Individuals with high mobility heavily rely on innovative mobile applications that provide them with the freedom and flexibility to connect and interact anytime, anywhere. Their prior experience with mobile applications is expected to facilitate mobile payment adoption (Venkatesh et al., 2003). People who already use some mobile applications may be more receptive to new mobile applications, less concerned with security issues associated with mobile payment, and find mobile payment easier to use and more compatible with their existing preferences than those without such experience. Those people tend to have positive attitude toward and high intention to adopt mobile payment, which fits their mobile lifestyle and satisfy their needs for ubiquitous access to payment service (Schierz et al., 2010). Furthermore, individuals with high mobility have become so used to relying on their mobile phones that they are likely to use mobile payment wherever and whenever possible, not just in the situations where time and location are critical for access to payment service. Therefore, individual mobility may negatively moderate the effects of the time and spatial criticality of access to payment service on the intention to use mobile payment. In other words, when individual mobility increases, the effects of time and spatial criticality of access to payment service on the intention to use mobile payment will become weaker. Hence, the following three hypotheses are proposed.

Hypothesis 9: Individual mobility of payment service user will have a positive effect on the intention to use mobile payment.

Hypothesis 10: The increased individual mobility will weaken the effect of the time criticality of access to payment service on the intention to use mobile payment.

Hypothesis 11: The increased individual mobility will weaken the effect of the spatial criticality of access to payment service on the intention to use mobile payment.

RESEARCH METHOD

To test the proposed research model and its associated hypotheses, we conducted a web-based survey to collect data from the existing users of smartphones. Only users of smartphones were recruited to participate in the study. The survey used a 2 (time criticality of access to mobile payment) x 2 (spatial criticality of access to mobile payment) between-subject design, producing 4 use contexts for mobile payment. The first factor consisted of two levels: Access to payment service is not time-critical or highly time-critical. The second factor also varied at two levels: Access to payment service is not spatial-critical or highly spatial-critical. Four hypothetical scenarios are designed to respectively induce four use contexts varying at 2 levels of time criticality of access to mobile payment and 2 levels of spatial criticality of access to mobile payment (See

Appendix A). These hypothetical scenarios were reviewed by several faculty members and students to ensure their appropriate wording.

Sample and Data Collection

An email invitation with a link to the survey was sent to an online survey panel consisting of adults who are at least 18 years old, use smart phones, and live in the New York metropolitan area. Cash incentive was provided to encourage participation in the survey. All the participants are smartphone users, but have never used mobile payment before. The participants were randomly assigned to each use context. Before starting the survey, the participants were instructed to watch a video clip of an individual using mobile payment technology to pay for a train ticket. Then, they were asked to rate their perception of mobile payment characteristics, such as perceived relative advantage, effort expectancy, compatibility, risks, subjective norm concerning mobile payment usage. Then, they read a hypothetical scenario that describes one of the four use contexts (See Appendix A). After that, they rated their intentions to use mobile payment and levels of individual mobility. A total of 249 useable responses were received. The response rate was 21.65%. 47% of the participants were females and 53% were males. The respondents' ages ranged from 18 to 80. 196 respondents were between 18 and 54 years old (78.71%), and 53 respondents were between 55 and 80 years old (21.29%).

Measures

Our survey instrument was developed by incorporating and adapting existing valid and reliable scales where possible (See Appendix B). All measurement items are scored on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) with 4 as a neutral midpoint (neither disagree nor agree).

DATA ANALYSIS AND RESULTS

We performed manipulation checks by conducting two independent sample t-tests respectively on the participants' perceived time criticality and spatial criticality of access to payment service. The results from these t-tests demonstrated the effectiveness of the manipulations of time criticality and spatial criticality of access to payment service. The participants reading the scenario describing a use context with high time criticality of access to payment service had a significantly higher mean score on the perceived time criticality of access to payment service ($t = 7.33$, $p < 0.001$, $Mean_{low\text{-}time\text{-}criticality} = 3.93$ vs. $Mean_{high\text{-}time\text{-}criticality} = 5.36$) than those who read the scenario intended for a use context with low time criticality of access to payment service. Likewise, the participants exposed to the scenario describing a use context with high spatial criticality of access to payment service had a significantly higher mean score on the perceived spatial criticality of access to payment service ($t=7.90$, $p<0.001$, $Mean_{low\text{-}spatial\text{-}criticality}=3.48$ vs. $Mean_{high\text{-}spatial\text{-}criticality}=5.15$) than those reading the scenario intended for a use context with low spatial criticality of access to payment service. A MANOVA test was also conducted using the measures of perceived time criticality and spatial criticality of access to payment service as the dependent variables and the manipulations of time criticality and spatial criticality of access to payment service as the independent variables. Consistent with the t-tests, the MANOVA test yielded significant main effects of the manipulation of time criticality ($F=27.36$, $p < 0.001$) and the manipulation of spatial

criticality of access to payment service of ($F=31.41$, $p < 0.001$). No significant interaction effect was found between these two factors. These results suggest that the participants were successfully induced into the respective use contexts that the hypothetical scenarios were intended for.

A component-based SEM (structural equation modeling) technique, partial least square (PLS) was used for data analysis. PLS is considered suitable for this study due to its superior prediction capability and minimal demands on sample size and residual distributions (Fornell & Bookstein, 1982; Chin, 1998a; Chin, 1998b). In addition, PLS allows us to test the psychometric properties of the measurement scales (the measurement model) and the relationships among the variables (the structural model) simultaneously. All the constructs were modeled using multiple reflective indicators. Each moderating effect was represented as an interaction term, which is a product term derived from the product of the indicators of the predictor and moderator constructs (Chin, Marcolin, & Newsted, 2003).

Measurement Model

The psychometric properties of the measurement scales for the factors were assessed in terms of convergent validity, discriminant validity, and reliability. All the factor loadings of the measurement items on their corresponding constructs exceed 0.70, indicating adequate convergent validity. To establish the discriminant validity, the measurement items should load higher on their respective constructs than the remaining constructs. The results indicate all the items' loadings on their own constructs were higher than the cross-loadings on other constructs. Another criterion for evaluating discriminant validity suggests that the average variance shared between the constructs and its indicators should be larger than the variance shared between the construct and other constructs (Fornell & Larcker, 1981). In other words, the square root of average variance extracted (AVE) of the constructs should exceed the inter-correlations among the constructs in the model (Chin, 1998b; Fornell & Larcker, 1981). The correlation matrix presented in Table 1 indicates that the square roots of AVE on the diagonal are greater than the corresponding off diagonal inter-construct correlations. Thus, the discriminant validity of all the factors is supported.

The reliability of the measurement items was examined using the statistics of Cronbach's alpha (Cronbach, 1971), composite reliability (Chin, 1998a), and AVE (Fornell & Larcker, 1981). It is suggested that Cronbach's alpha should exceed 0.70 (Cronbach, 1971), AVE should be 0.5 or greater (Fornell & Larcker, 1981), and composite reliability should be above 0.70 (Chin, 1998a) to indicate adequate reliability. Table 1 shows that all the values of composite reliability, AVE, and Cronbach's alpha are well above the 0.70, 0.50, and 0.70 thresholds. These results indicate high reliability of the items.

Since a single questionnaire was used to collect all measures in this study, common method bias (CMB) could be viewed as a potential problem. First, we conducted the Harman's single factor test to investigate common method bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). An unrotated exploratory factor analysis was performed on all items to assess the fit of a single factor model. The variance extracted for the one-factor solution was below 50% (42.97%). It appears that no single factor accounts for the majority of the covariance among the measures (Podsakoff et al., 2003). Second, we checked the correlation matrix of the latent variables (see Table 1). The highest correlation is 0.741, which is lower than the correlation coefficient indicating common method bias (0.90) (Pavlou, Liang, & Xue, 2007). Third, we incorporated a latent common method

variance factor (LCMVF) in the PLS model (Podsakoff et al., 2003). Each item loads on the LCMVF and on the original construct it is intended to measure. The LCMVF was modeled using Liang et al.'s approach (Liang, Saraf, Hu, & Xue, 2007). All the constructs and the LCMVF are modeled as second-order constructs. Each indicator is represented as a single-indicator first-order construct, which loads on both the LCMVF and its respective construct. This method enables the assessment of the influence of CMB on the indicators because it allows the calculation of each indicator's variances as substantively explained by the theorized construct as well as by the method. As a result of the test, we found that the factor loadings in the measurement models with and without the LCMVF are significant and of similar magnitude. The path coefficients of the structural models, with and without the LCMVF, also showed same directions at similar significant levels. Therefore, the above analyses do not indicate severe common method bias.

Table 1. Inter-Construct Correlation, Square Root of AVE, Composite Reliability, and Cronbach's Alpha of Constructs

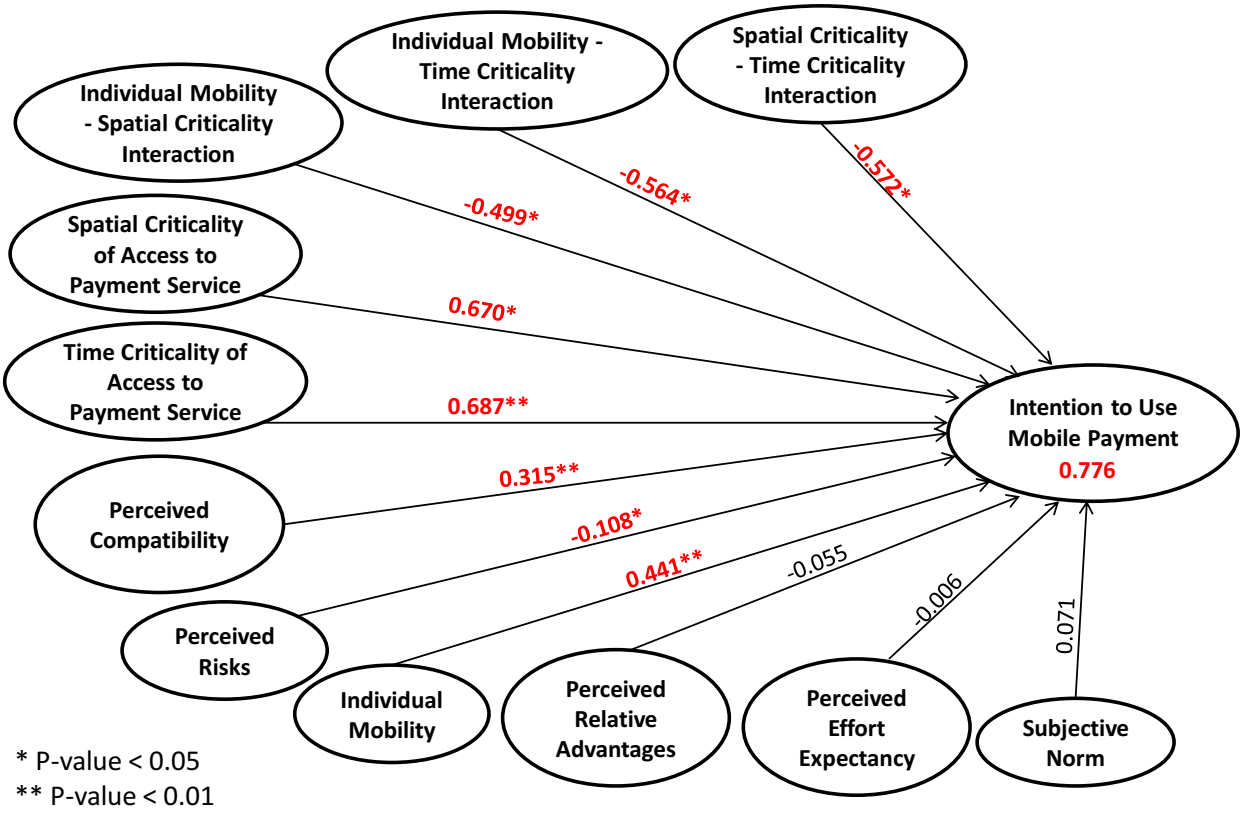
	Composite Reliability	Cronbach's Alpha	RA	CP	EE	IM	PR	SN	SC	TC	BI
RA	0.949	0.937	0.870								
CP	0.970	0.963	0.741	0.918							
EE	0.958	0.945	-0.792	-0.757	0.906						
IM	0.979	0.967	0.179	0.193	-0.211	0.969					
PR	0.897	0.770	-0.712	-0.750	0.700	-0.161	0.902				
SN	0.975	0.962	0.614	0.650	-0.520	0.226	-0.563	0.964			
SC	0.919	0.869	0.054	0.005	-0.028	0.549	0.018	0.070	0.890		
TC	0.939	0.902	0.153	0.144	-0.089	0.640	-0.041	0.213	0.580	0.916	
BI	0.994	0.992	0.333	0.417	-0.326	0.691	-0.339	0.382	0.622	0.691	0.989

RA = Relative Advantage, CP = Compatibility, EE = Effort Expectancy, IM = Individual Mobility, PR = Perceived Risks, SN = Subjective Norm, SC = Spatial Criticality, TC = Time Criticality, BI = Behavioral Intention

PLS Structural Model

The path coefficients and explained variances for the structural model are shown in Figure 2. PLS model does not generate the model fit statistics, but uses the R square values (explained variance) in the dependent constructs to assess the explanatory power of a structural model. Figure 2 shows that all the proposed independent variables and moderating effects accounted for 77.6% of the variance in behavioral intention to use mobile payment.

Figure 2. PLS Structural Model Results



As indicated by the path coefficients in Figure 2, the PLS results suggest that certain perceived characteristics of mobile payment are significant predictors of the intention to use mobile payment. As expected, perceived compatibility and risks of mobile payment were found to influence the intention to use mobile payment, hence providing support for hypotheses 3 and 4. The results provided support for the hypotheses pertaining to the effects of use context of mobile payment. The results indicated that both spatial criticality (Hypothesis 6) and time criticality (Hypothesis 7) of access to payment service were significant positive predictors of the intention to use mobile

payment. The negative moderating effect of time criticality of access to payment service on the relationship between spatial criticality of access to payment service and mobile payment adoption intention was also supported (Hypothesis 8). The results also revealed the significant positive effect of individual mobility of payment service user on mobile payment adoption intention (Hypothesis 9), as well as the negative moderating effects of individual mobility on the effects of time and spatial criticality of access to payment service on mobile payment adoption intention (Hypotheses 10 and 11). Contrary to our expectation, perceived relative advantages and effort expectancy of mobile payment and subjective norm regarding mobile payment adoption were found to have no impact on the intention to use mobile payment. Thus, hypotheses 1, 2, and 5 were not supported. Table 2 presents a summary of the hypotheses testing results.

Table 2. Summary of Hypotheses Tests

Relationships	Support
H1: Perceived Relative Advantages → Intention to Use Mobile Payment	No
H2: Perceived Effort Expectancy → Intention to Use Mobile Payment	No
H3: Perceived Compatibility → Intention to Use Mobile Payment	Yes
H4: Perceived Risks → Intention to Use Mobile Payment	Yes
H5: Subjective Norm → Intention to Use Mobile Payment	No
H6: Spatial Criticality of Access to Payment Service → Intention to Use Mobile Payment	Yes
H7: Time Criticality of Access to Payment Service → Intention to Use Mobile Payment	Yes
H8: Time Criticality x Spatial Criticality Interaction → Intention to Use Mobile Payment	Yes
H9: Individual Mobility → Intention to Use Mobile Payment	Yes
H10: Individual Mobility x Time Criticality Interaction → Intention to Use Mobile Payment	Yes
H11: Individual Mobility x Spatial Criticality Interaction → Intention to Use Mobile Payment	Yes

DISCUSSION

The purpose of this study was to identify and empirically test the factors affecting the adoption of mobile payment. In total, the high R^2 value (77.6%) of the intention to adopt mobile payment highlights a comprehensive set of important factors that are associated with user adoption of mobile payment. Our results indicate that the intention to adopt mobile payment is determined by the perceived characteristics of mobile payment, the use context of mobile payment, and the individual characteristic of potential users. Among the perceived characteristics of mobile payment under study, only the perceived compatibility and perceived risks of mobile payment have significant effects on the intention to adopt mobile payment. Therefore, individuals who consider mobile payment to be of low risks and compatible with their lifestyles and habits are likely to use mobile payment. The results, however, did not support the impacts of perceived relative advantages and effort expectancy of mobile payment. No support was found for the effect of social influence either.

The time criticality and spatial criticality of access to payment service are identified as critical variables characterizing the use context of mobile payment. The results show that these characteristics of mobile payment use context are more important predictors of mobile payment adoption intention than the perceived characteristics of mobile payment. Individuals would prefer to use mobile payment in situations when payment must be made urgently and/or at a particular location. In addition, the time criticality of access to payment attenuates the relationship between the spatial criticality of access to payment service and the intention to adopt mobile payment. When time is not critical for the access to payment service, the spatial criticality of access to payment service serves as a crucial determinant of the intention to adopt mobile payment. But in situations when time is critical for the access to payment service, the impact of the spatial criticality of access to payment service on mobile payment adoption intention will decrease, because the urgent need for payment service may lead to the use of mobile payment regardless of location.

The individual mobility of potential users also has a significant effect on mobile payment adoption intention. People with high mobility are more likely to use mobile payment than those with low mobility. Furthermore, the results revealed the negative moderating effects of individual mobility on the effects of the characteristics of mobile payment use context on mobile payment adoption intention. For the individuals with low mobility, the characteristics of mobile payment use context are major determinants driving their intention to adopt mobile payment. However, the effect of use context diminishes for individuals with high mobility. That is, highly mobile individuals tend to use mobile payment regardless of use context.

CONCLUSIONS

The major contributions of this study are as follows. First, it developed a more comprehensive theoretical model of mobile payment adoption by integrating traditional technology adoption theories and findings of more recent studies of mobile payment. The model incorporates not only the perceptions of mobile payment characteristics, but also the characteristics of mobile payment use context and the individual characteristics of mobile payment user, which are usually overlooked in traditional technology adoption research. Compared to the perceived characteristics of mobile payment, the characteristics of mobile payment use context and the individual

characteristics of potential users play more important roles in determining mobile payment adoption intention. Second, this study identified two important characteristics of mobile payment use context – the time criticality and spatial criticality of access to payment service, which are critical predictors of mobile payment adoption intention. In addition to their independent effects, this study also revealed their interaction effect on mobile payment adoption intention. The increased time criticality of access to mobile service will attenuate the relationship between the spatial criticality of access to payment service and mobile payment adoption intention. Third, this study highlighted the critical role of user's individual mobility in the adoption of mobile payment. Individual mobility is not only a significant predictor of mobile payment adoption intention, but it also weakens the impacts of the characteristics of mobile payment use context on mobile payment adoption intention.

The findings of this study provide significant implications for the future development and provision of mobile payment technology. Our findings suggest that developers of mobile payment technology should focus on usage situations, where payments must be made urgently and/or at a particular location, making mobile payment more feasible than other payment methods. At the same time, the technology should also satisfy the requirements related to low risks and compatibility with users' individual behavioral patterns, experiences, and preferences. In addition, individual mobility is a key determinant of mobile payment adoption. Although companies cannot easily change customers' individual characteristics, our finding can help companies to better define target customer profile and promote mobile payment technology to highly mobile individuals who are likely to use mobile payment in every life situation.

Several limitations should be considered when interpreting the results of this study. First, the data were collected from a sample of smartphone users in the USA, which may restrict the applicability of the results to other populations, such as non-smartphone users or smartphone users from other countries, especially the developing countries. Since mobile payment technology replies on modern mobile devices, such as smartphones, people's lack of access to mobile device may hinder their intention to use mobile payment and confound the results of the study. As the access to mobile device is not a variable of interest in this study, the use of smartphone user sample is necessary to eliminate the effect of irrelevant confounding variable and should not present a serious threat to the validity of this study. Future research can address the generalizability issue of this study by replicating the study with samples from other countries and regions in the world. Second, there may be other possible variables affecting mobile payment adoption that were not included in our research model, such as individual innovativeness of potential users, network externalities of mobile payment technology, perceived reputation of technology providers, and so on. This limitation also paves the way to future studies. Despite the above-mentioned limitations, we believe that this paper contributes to a better insight of mobile payment adoption and provides guidelines for the future improvement of mobile payment technology development and provision.

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APPENDIX A

		Time Criticality of Access to Payment Service	
		Critical	**Non-Critical**
Spatial Criticality of Access to Payment Service	**Critical**	You want to purchase a ticket for a train leaving in FIVE MINUTES. A train ticket must be purchased before you will be allowed to get on the train. You must buy the ticket at the TICKET OFFICE IN THE TRAIN STATION or you can use your MOBILE PHONE to pay for the ticket without going through the ticket office.	You want to purchase a ticket for a train leaving TOMORROW. The ticket must be purchased before you will be allowed to get on the train. You must buy the ticket at the TICKET OFFICE IN THE TRAIN STATION or you can use your MOBILE PHONE to pay for the ticket without going through the ticket office.
	Non-Critical	You want to purchase a ticket for a train leaving in FIVE MINUTES. The ticket must be purchased before you will be allowed to get on the train. You can purchase it online using your computer AT HOME, or go to the TICKET OFFICE IN THE TRAIN STATION to buy the ticket, or use your MOBILE PHONE to pay for the ticket without using a computer or going through the ticket office.	The ticket must be purchased before you will be allowed to get on the train. You can purchase it online using your computer AT HOME, or go to the TICKET OFFICE IN THE TRAIN STATION to buy the ticket, or use your MOBILE PHONE to pay for the ticket without using a computer or going through the ticket office.

APPENDIX B

Relative Advantages (Moore & Benbasat, 1991; Mallat et al., 2009; Kim et al., 2010)
Using mobile payment enables me to make payments more quickly.
Using mobile payment makes it easier for me to make payments.
Using mobile payment makes it more effective for me to make payments.
Using mobile payment gives me greater control in making payments.
Using mobile payment enables me to make payments anytime when needed.
Using mobile payment enables me to make payments anywhere where needed.

Perceived Effort Expectancy / Perceived Ease of Use (Kim et al., 2010)
My interaction with mobile payment procedure would be clear and understandable.
It would be easy for me to become skillful at using mobile payment.
I would find mobile payment easy to use.
Learning to use mobile payment is easy for me.
I would find mobile payment procedure to be flexible to interact with.

Perceived compatibility (Moore & Benbasat, 1991; Mallat et al., 2009; Schierz et al., 2010)
Using mobile payment fits well with my style and habits.
Using mobile payment fits well with the way I like to purchase products and services.
Using mobile payment is compatible with my current situation.
Using mobile payment is compatible with my other use of mobile phone.
Mobile payment is a suitable method for me to make payments.
I would appreciate using mobile payment instead of alternative modes of payment (e.g., credit card, cash, etc.).

Perceived Risks (Schierz et al., 2010)
I am certain mobile payment will work satisfactorily.
I would find mobile payment risky in conducting my payment transactions.
The risk is low when using mobile payment.

Subjective Norm (Schierz et al., 2010)
People who are important to me would recommend using mobile payment.
People who are important to me would find using mobile payment beneficial.
People who are important to me would find using mobile payment a good idea.

Individual Mobility (Schierz et al., 2010)
I would like to be able to keep in touch everywhere I am.
I would like to be able to coordinate my daily tasks everywhere I am.
I would like to be able to coordinate my daily tasks no matter what time it is.

Behavioral Intention to Use Mobile Payment (Kim et al., 2010; Schierz et al., 2010)
Assuming that I have access to mobile payment, I intend to use it.
I am willing to use mobile payment.
Given that I have access to mobile payment, I predict that I would use it.
I am likely to use mobile payment.

Perceived Time Criticality of Access to Payment Service (New Measure)
I must purchase the train ticket right now.
It is urgent for me to purchase the train ticket now.
There is plenty of time left for me to purchase the ticket.

Perceived Spatial Criticality of Access to Payment Service (New Measure)
If I do not use mobile payment, I can only purchase the train ticket at the ticket office in the train station.
Even if I do not use mobile payment, I can still purchase the train ticket at some place other than the ticket office in the train station.
If I do not use mobile payment, the ticket office in the train station is the only place where I can purchase the train ticket.

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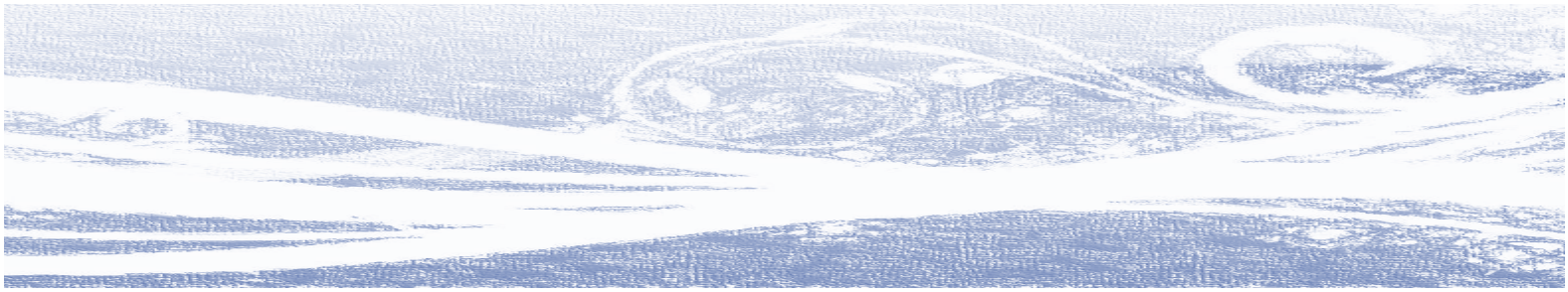

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