



Contents lists available at ScienceDirect

## Computers in Human Behavior

journal homepage: [www.elsevier.com/locate/comphumbeh](http://www.elsevier.com/locate/comphumbeh)

## An empirical examination of factors influencing the intention to use mobile payment

Changsu Kim<sup>a,1</sup>, Mirsobit Mirusmonov<sup>a</sup>, In Lee<sup>b,\*</sup><sup>a</sup> School of Business, Yeungnam University, South Korea<sup>b</sup> Department of Information Systems and Decision Sciences, College of Business and Technology, Western Illinois University, Macomb, IL 61455, USA

## ARTICLE INFO

## Article history:

Available online xxxxx

## Keywords:

Mobile payment  
System characteristics  
Individual differences  
Mobile payment users

## ABSTRACT

With recent advances in mobile technologies, mobile commerce is having an increasingly profound impact on our daily lives, and beginning to offer interesting and advantageous new services. In particular, the mobile payment (m-payment) system has emerged, enabling users to pay for goods and services using their mobile devices (especially mobile phones) wherever they go. Mobile payment is anticipated to enjoy a bright future.

In this paper, we reviewed the relevant literature regarding mobile payment services, analyzed the impact of m-payment system characteristics and user-centric factors on m-payment usage across different types of mobile payment users, and suggested new directions for future research in this emerging field. To analyze the adoption behaviors of m-payment users, we proposed an m-payment research model which consists of two user-centric factors (personal innovativeness and m-payment knowledge) and four m-payment system characteristics (mobility, reachability, compatibility, and convenience). We evaluated the proposed model empirically, applying survey data collected from m-payment users regarding their perceptions on mobile payment. We also attempted to categorize m-payment users into early and late adopters and delineated the different factors for these two types of adopters that affect their intention to use m-payment.

The results indicate that the strong predictors of the intention to use m-payment are perceived ease of use and perceived usefulness. All respondents reported that the compatibility of m-payment was not the primary reason in their decision to adopt it. Interestingly, our findings indicate that early adopters value ease of use, confidently relying on their own m-payment knowledge, whereas late adopters respond very positively to the usefulness of m-payment, most notably reachability and convenience of usage. Moreover, late adopters' perceived ease of use is influenced by personal innovativeness, which can probably be best explained by the fact that innovative late adopters are tech-savvy and feel confident to use m-payment technologies for their needs.

Our study will assist managers in implementing appropriate business models and service strategies for different m-payment user groups, allowing them to exert appropriate time, effort, and investment for m-payment system development. Our study also provides directions for future mobile payment-related studies.

© 2009 Elsevier Ltd. All rights reserved.

## 1. Introduction

Mobile commerce involves the sale of goods, services, and contents via wireless devices, without time or space limitations (Au & Kauffman, 2008; Mallat, 2007). As mobile commerce increases in popularity, mobile payment will continue to facilitate secure electronic commercial transactions between organizations or individuals (Ondrus & Pigneur, 2006). In this study, mobile payment or m-payment is defined as any payment in which a mobile device is uti-

lized to initiate, authorize, and confirm a commercial transaction (Au & Kauffman, 2008). Mobile payment is a natural evolution of electronic payment, and enables feasible and convenient mobile commerce transactions (Mallat, 2007). M-payments are typically made remotely via premium rate SMS, WAP billing, Mobile Web, Direct-to-subscribers' bill and direct to credit cards. According to Juniper Research (2008), the gross transaction value of payments made via mobile phone for digital goods (such as music, games and ticketing) and physical goods (such as gifts, books or consumer electronics) will exceed \$300 billion globally by 2013. The report predicts that the global annual gross transaction value will grow over 5 times and ticketing segment will represent over 40% of the global transaction value by 2013.

\* Corresponding author. Tel.: +1 309 298 1409; fax: +1 309 298 1696.

E-mail addresses: [c.kim@yumail.ac.kr](mailto:c.kim@yumail.ac.kr) (C. Kim), [I-Lee@wiu.edu](mailto:I-Lee@wiu.edu) (I. Lee).<sup>1</sup> Tel.: +82 (0)53 810 2752; fax: +82 (0)53 810 3213.

Because electronic commerce organizations may achieve competitive advantage via the provision of mobile payments to customers, the issues associated with appropriate mobile payment usage are of critical importance (Au & Kauffman, 2008; Mallat, 2007; Ondrus & Pigneur, 2006). In particular, the mobile user's intention to use mobile payment is of considerable interest to researchers and practitioners, because financial institutions, trusted third parties, payment service providers, and systems, software and supporting service providers can benefit greatly from enhanced understanding of the key factors underlying mobile users' intention (Dahlberg, Mallat, & Öörni, 2003a; Dahlberg, Mallat, & Öörni, 2003b; Lim, 2007; Ondrus & Pigneur, 2006). Moreover, different user groups may perceive m-payment advantages differently and adopt new payment technologies accordingly. While there is a need to understand the user-group level behavior, there is little attempt to fill a gap in the user-group level research. In light of the current state of the existing research on m-payment, the objective of this study is to empirically assess the determinants of the intention to use m-payment. In order to achieve this objective, we propose a research model that consists of two user-centric factors and four m-payment system characteristics, two belief variables, and one user acceptance variable.

The technology acceptance model (TAM) is a well-recognized model used to explain IS adoption behavior (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989). According to the TAM, adoption behavior is determined by the intention to utilize a particular system, which is, in turn, determined by the perceived usefulness and the perceived ease of use of the system. One major benefit of using the TAM is that it provides a framework by which the effect of external variables on system usage can be assessed. In order to adapt the TAM to the mobile payment context, we integrated it with user-centric factors and four m-payment system characteristics. Moreover, in order to further our understanding of the users' adoption behavior, we categorized m-payment users into early and late adopters and investigated the user-group level behavior.

The remainder of the paper is organized as follows: Section 2 develops the theoretical background of our study, focusing on the technology acceptance theories and m-payment. Section 3 presents the research model and hypotheses. Section 4 provides a discussion of the research methods. Section 5 provides the analysis of the survey results. Section 6 discusses the results. Section 7 follows with the summary, contributions, implications, and limitations of the study.

## 2. Theoretical background

In this section, the theoretical background of our study is developed with the literature review of the technology acceptance theories, mobile payment systems, mobile payment system characteristics, and individual differences.

### 2.1. Technology acceptance theories

A number of research models have been introduced to explain computer-usage behavior. Fishbein and Ajzen's (1975) Theory of Reasoned Action (TRA), which depicts user behavior from social psychology's point, is the theoretical basis of Theory of Planned Behavior (TPB) (Ajzen, 1991), Technology Acceptance Model (TAM) (Davis, 1986) and Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003). TRA is very general in nature and attempts to explain almost any human behavior. According to TRA, a person's performance of a specified behavior is determined by his or her behavioral intention (BI) to perform the behavior, and BI is jointly determined by the

person's attitude and subjective norm concerning the behavior in question.

TAM is one of the first and the most influential research models to explain users' IT adoption behavior (Davis et al., 1989). The TAM has been recognized as a useful model of technology acceptance behaviors in a variety of IT contexts, and is currently widely applied among researchers of information systems in general. The fundamental rationale of the TAM is that IT users act rationally when they decide to use an IT. In the process of users' intention to use new IT, two belief variables – perceived usefulness (PU) and perceived ease of use (PEU) of the system – are the most salient factors in users' intention. Perceived usefulness is defined as the degree to which a person perceives that adopting the system will boost his/her job performance. Perceived ease of use is defined as the degree to which a person believes that adopting the system will be free of effort. Perceived usefulness has an immediate effect on adoption intention, whereas perceived ease of use has both an immediate effect and an indirect effect on adoption intention via perceived usefulness. In TAM2 (Venkatesh & Davis, 2000), an extended TAM, social and organizational variables such as subjective norm, image, job relevance, output quality, and result demonstrability are included in the model. All these factors are shown to have direct impact on PU. In addition, the study shows that subjective norm not only influences PU, but also has impact on user intention.

UTAUT (Venkatesh et al., 2003) proposes four key constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) as direct determinants of usage intention and behavior. Note that in UTAUT, performance expectancy is the same as TAM's perceived usefulness, and is defined as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance." Like perceived ease of use in TAM, effort expectancy refers to "the degree of ease associated with the use of the system." Unlike TAM, UTAUT introduces moderating constructs (gender, age, experience, and voluntariness of use) which are posited to moderate the impact of the four key constructs on usage intention and behavior.

Even with the wealth of currently available research involving the TAM and UTAUT, the models continue to be explored and improved in new research (Luarn & Lin, 2005). In the new research, studies assessing the acceptance of new technologies with different user populations are clearly required. The TAM can be extended to investigate users' intention to use m-payment, as mobile payment systems are a type of new information technology.

The individual differences and system characteristics are the two primary constructs that have been recognized in the past research. Individual differences were deemed to be the most significant variables to IS success in the theoretical model put forward by Zmud (1979). The importance of individual difference variables in new technology acceptance was also underlined by Nelson (1990). Moreover, the significant relationship between individual differences and IT acceptance has been demonstrated in several empirical studies involving the TAM (Agarwal & Prasad, 1999; Venkatesh, 2000). The integration of individual differences into the system design is considered to be beneficial to human mobile device interactions (Mallat, 2007; Ondrus & Pigneur, 2006). As such, assessing the effects of individual differences in m-payment adoption would be of critical importance.

Mobile payment system characteristics constitute another category of external variables that may potentially affect users' intention to adopt new IS. Davis (1989) suggested that the design characteristics of a system exert immediate effects on perceived usefulness as well as indirect effects via perceived ease of use. M-payment system features are also thought to play a vital role in the usage of m-payments. However, the assumptions regarding the manner in which the acceptance of m-payment systems will be

affected by various system characteristics have yet to be empirically verified. Hence, this study will shed some light on these assumptions by incorporating m-payment system characteristics into our research model.

## 2.2. Mobile payments

M-payment is an alternative payment method for goods, services, and bills/invoices. It uses mobile devices (such as a mobile phone, smart-phone, or Personal Digital Assistant) and wireless communication technologies (such as mobile telecommunications networks, or proximity technologies). Mobile devices can be utilized in a variety of payments, such as payments for digital content (e.g. ring tones, logos, news, music, or games), concert or flight tickets, parking fees, and bus, tram, train and taxi fares. Mobile devices access and utilize mobile payment services to pay bills and invoices. Mobile devices allow the users to connect to a server, perform authentication and authorization, make a mobile payment and subsequently confirm the completed transaction (Antovski & Gusev, 2003; Ding & Hampe, 2003b).

A mobile payment service comprises all technologies offered to the user as well as all tasks conducted by the payment service providers to carry out payment transactions. A number of technology architectures/solutions have been proposed to improve cost, functionalities, scalability and security (Guo, 2008; Manvi, Bhajantri, & Vijayakumar, 2009; Massoth & Bingel, 2009; Mohammadi & Jahan-shahi, 2008; Rahimian & Habibi, 2008). Mobile payment services involve certain parties which perform unique value-adding roles in the m-payment delivery chain (Dahlberg, 2007). Payments fall broadly into two categories; payments for purchases and payments of bills/invoices (Karnouskos & Fokus, 2004). In payments for purchases, mobile payments compete with or complement cash, checks, credit cards, and debit cards. In payments of bills/invoices, mobile payments typically provide access to account-based payments, including money transfers, online banking payments, or direct debit assignments.

A number of studies have focused on the adoption factors of m-payment. These studies have been based primarily on the TAM, with additional constructs adapted for the study of m-payment such as security, cost, trust, mobility, expressiveness, convenience,

speed of transaction, use situation, social reference groups, facilitating condition, the attractiveness of alternatives, privacy, system quality, and technology anxiety (Chen & Adams, 2005; Cheong, Park, & Hwang, 2004; Dahlberg, Mallat, Penttinen, & Sohlberg, 2002; Dahlberg et al., 2003a; Dahlberg et al., 2003b; Dewan & Chen, 2005; Mallat, 2004; Mallat & Dahlberg, 2005; Torsten, Gerpott, & Kornmeier, 2009; Valcourt, Robert, & Beaulieu, 2005; Zmijewska, Lawrence, & Steele, 2004b). Due to the complexity and dynamism of the m-payment diffusion, multiple perspectives are needed to account for diffusion challenge, and market-level and behavioral facets need more attention in explaining m-payment diffusion (Ondrus, Lyytinen, & Pigneur, 2009). The previous studies tend to overlook the system characteristics and individual differences specially pertaining to m-payment. More research is required to determine whether these factors influence the intention to use m-payment.

Overall, the above-mentioned theoretical models have contributed to our understanding of user acceptance factors and behavior. However, there is still a need for further studies in m-payment users' behavior. While UTAUT is a good candidate for our study, we believe that the extension of TAM serves our research purposes better than UTAUT. The constructs used in our model (i.e., individual differences and system characteristics) are more specific than the generalized constructs used in UTAUT. We posit that systems characteristics and individual differences affect users' perception of m-payment. To investigate individual differences in detail, two factors, personal innovativeness and m-payment knowledge, were identified. Along with these two factors related to individual differences, we also identified four system characteristics (mobility, reachability, compatibility, and convenience). Below we discuss in detail each category with its constructs.

## 3. Research model and hypotheses

Previous research has identified two principal categories of external variables – namely, individual differences and system characteristics – as major external variables of the TAM (Agarwal & Prasad, 1999; Davis, 1993; Venkatesh, 2000). The proposed research model includes two constructs of the individual differences and four constructs of m-payment system characteristics (MPS) (see Fig. 1).

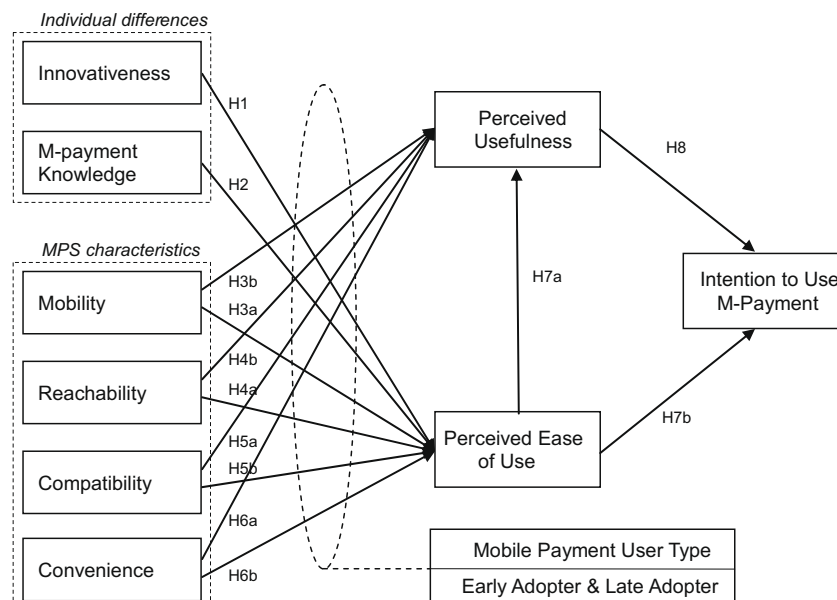


Fig. 1. Research model.

### 3.1. Individual differences

Individual differences are regarded as the most relevant variables to both IS success (Agarwal & Prasad, 1999; Chen, Czerwinski, & Macredie, 2000; Karahanna, Ahuja, Srite, & Galvin, 2002; Sun & Zhang, 2006; Zmud, 1979) and technological interaction (Dillon & Watson, 1996). From the perspective of mobile commerce, it seems that individual differences have been generally expected to be related to m-commerce usage. Previous m-commerce studies have introduced a user-centric model to assess user's acceptance motivations and preferences (Coursaris & Hassanein, 2002; Zmijewska, Lawrence, & Steele, 2004a; Zmijewska et al., 2004b). Interest in the individual differences is growing in the user behavior studies of m-payment. In this study, we will examine two individual difference constructs, mobile payment knowledge and innovativeness, which have been deemed important in IS and mobile service literature (Chen et al., 2000; Tariq, 2007). These two constructs were selected because it appears they are related to m-payment usage, as is described in the following sections.

#### 3.1.1. Personal innovativeness

Personal innovativeness is explained as the inclination of an individual to try out any new information systems (Chang, Cheung, & Lai, 2005). Personal innovativeness has a significant positive effect on online shopping decisions (Blake, Neuendorf, & Valdiserri, 2003; Crespo & del Bosque, 2008). Another study has shown that domain specific personal innovativeness predicts well the adoption behavior of IT innovations (Yi, Fiedler, & Park, 2006). Innovative individuals have also been shown to be communicative, curious, dynamic, venturesome, and stimulation-seeking. It has been agreed that highly innovative individuals are active information seekers with regard to new ideas (Tariq, 2007). The majority of individuals still have relatively little expertise regarding various new mobile services and therefore innovativeness will play an important role in the intention to adopt the new mobile technologies. Considering the relative infancy of mobile services, it is appropriate to test innovativeness as an influencing variable under new circumstances of m-payment. According to the above observations, it is generally expected that personal innovativeness should have a profound positive impact on perceived ease of use, which in turn should influence users' intention to adopt m-payment. Thus, this study hypothesizes the following:

**H1.** Personal innovativeness will have a positive effect on the perceived ease of use of m-payment.

#### 3.1.2. M-payment knowledge

Given that there have been very few studies conducted thus far addressing m-payment knowledge, this study attempts to determine whether any relationship exists between m-payment knowledge and the intention to use m-payment. Web novices tend to rely on the most basic and attractive features of the website interface, while Web experts use their experience and can utilize their knowledge to facilitate their information processing and to differentiate between relevant and irrelevant information (Rieh, 2004). The number of people who use mobile phones already exceeded the number of people who use fixed lines connected to the Internet (Dholakia & Rask, 2002). Given the popularity of the mobile devices, it is of great importance to know if those who already use some mobile services or those who are not afraid to disclose their personal information to mobile vendors would not mind experiencing more exposure through m-payment. With the limited amount of research on this subject, this study attempts to explore the impact of m-payment knowledge on the perceived ease of m-payment use. Mobile users with a high level of m-payment knowledge are likely to find the m-payment systems to be easier

to use than mobile users lacking such knowledge. Thus, this study hypothesizes the following:

**H2.** M-payment knowledge will have a positive effect on the perceived ease of use of m-payment.

### 3.2. Mobile payment system characteristics

System characteristics have the potential to affect directly both the perceived ease of use and the perceived usefulness of IS (Davis et al., 1989). Previous research involving system qualities as external constructs of TAM has suggested strong relationships between the system characteristics and the TAM's theoretical constructs (Davis, 1993; Venkatesh & Davis, 1996; Venkatesh & Davis, 2000). As mobile commerce and related m-payment grow rapidly in importance, it is necessary to identify specific system characteristics and assess their individual effects on both the perceived ease of use and the perceived usefulness of m-payment.

Mobile technology is a broad category which addresses all devices, protocols, and infrastructures that permit one to communicate and exchange data with other individuals or systems anywhere and anytime (Lim, 2007). With regard to mobile technology, the unique attributes include mobility and reachability, which provide mobile payments with advantages over online payments (Ding, Ijima, & Ho, 2004). Mobility implies that users can carry cell phones or other mobile devices to conduct transactions from anywhere within a mobile network area (Au & Kauffman, 2008; Ding et al., 2004). Reachability of the mobile devices makes it possible for people to be contacted anytime and anywhere, and provides users with the choice to limit their reachability to particular people or times (Perry, O'hara, Sellen, Brown, & Harper, 2001). The detailed explanations of m-payment systems (MPS) characteristics are as follows.

#### 3.2.1. Mobility

The most significant quality of mobile technology is mobility *per se*: the ability to access services ubiquitously, on the move, and via wireless networks and a variety of mobile devices, including PDAs and mobile phones (Au & Kauffman, 2008; Clarke, 2001; Coursaris & Hassanein, 2002; Mallat, 2007; Nohria & Leestma, 2001). In comparison with conventional electronic commerce, in which transactions are conducted commonly via wire-Internet, mobile computing provides users with more freedom and value, allowing them to access time-critical information and services regardless of time and place (Anckar & D'Incau, 2002; May, 2001). Au and Kauffman (2008) labeled the benefits provided by mobile technologies as "anytime and anywhere computing" and defined the two most common dimensions of mobility – independence of time and place. The temporal and spatial dimensions of mobility broaden computing capacity and allow, in principle, access to information, communication, and services anywhere and anytime. These observations lead to the following hypotheses:

**H3a.** Mobility will have a positive effect on the perceived ease of use of m-payment.

**H3b.** Mobility will have a positive effect on the perceived usefulness of m-payment.

#### 3.2.2. Reachability

Reachability of the mobile devices makes it possible for people to be contacted anytime and anywhere, and provides users with the choice to limit their reachability to particular people or times (Au & Kauffman, 2008; Ng-Kruelle, Swatman, Rebme, & Hampe, 2002; Ondrus & Pigneur, 2006). This feature renders m-payment users reachable by m-payment service providers. Transactions



such as mobile payments require service providers to actively participate. There may be situations in which the m-payment user must be contacted for some clarifications. For example, financial service providers might attempt to reach m-payment users to inform them of recent mobile transactions, account balance, etc. This reachability makes it easy for mobile service providers to contact m-payment users for informational purposes, clarifying by calls and emails through a mobile device. Thus, with the greater reachability afforded by the m-payment systems, users will tend to be more willing to engage in mobile payments. These observations lead to the following hypotheses:

**H4a.** Reachability will have a positive effect on the perceived ease of use of m-payment.

**H4b.** Reachability will have a positive effect on the perceived usefulness of m-payment.

### 3.2.3. Compatibility

Studies on mobile banking verify its relative advantage over other existing banking services. Mobile services' compatibility with user needs and lifestyles, and the possibility of trying out a new service have a positive effect on attitudes towards adoption (Ding et al., 2004; Mallat, 2004). A previous study has noted the similarity of perceived usefulness and ease of use constructs in the TAM (Mallat & Dahlberg, 2005). The perceived usefulness and ease of use variables can be assumed to be parallel with each other, and together with compatibility they have been shown to be the most significant indicators of adoption (Mallat, Rossi, & Tuunainen, 2006). We consider that compatibility has an indirect effect on user's intention to use m-payment through perceived ease of use and perceived usefulness. Therefore, we propose the following hypotheses:

**H5a.** Compatibility will have a positive effect on the perceived ease of use of m-payment.

**H5b.** Compatibility will have a positive effect on the perceived usefulness of m-payment.

### 3.2.4. Convenience

Many believe profoundly in the benefits of technology, but only when technology is premised on the intention to make life easier for people and to ameliorate the difficulty of common tasks (Obe & Balogu, 2007). Convenience as a research construct has primarily been discussed in the marketing and consumer behavior literature (Berry, Seiders, & Grewal, 2002; Jih, 2007; Ng-Kruelle et al., 2002). Convenience has also been identified as one of the most important factors in the success of mobile commerce (Xu & Gutierrez, 2006). Convenience is related to the elements generating time and place utility for users (Clarke, 2001). In a study of mobile ticketing services for public transportation, Mallat et al. (2006) assumed that the intention to use mobile services is affected by the circumstances of use, such as the availability of other alternatives and time pressure in the service use situations. Considering the definition provided above, we can conclude that convenience is nothing but a combination of time and place utilities, which are clearly principal characteristics of m-payment. We propose that convenience exerts a positive effect both on the perceived ease of use and the perceived usefulness of m-payment.

**H6a.** Convenience will have a positive effect on the perceived ease of use of m-payment.

**H6b.** Convenience will have a positive effect on the perceived usefulness of m-payment.

### 3.3. Perceived ease of use

Many studies over the past decade have pointed to evidence regarding the critical effect of perceived ease of use on intention, either directly or indirectly with its effect on perceived usefulness (Davis et al., 1989; Venkatesh & Davis, 1996, 2000; Agarwal & Prasad, 1999). To prevent the underutilized m-payment system usages, m-payment must be both easy to learn and easy to use. Hence, we hypothesize that the perceived ease of use of m-payment should exert a positive effect on both the perceived usefulness and intention to use m-payment.

**H7a.** Perceived ease of use will have a positive effect on the perceived usefulness of m-payment.

**H7b.** Perceived ease of use will have a positive effect on the intention to use m-payment.

### 3.4. Perceived usefulness

Users' intention to use an information technology is predicated, to a large degree, on their perceived usefulness of the system (Davis et al., 1989). There is also a certain amount of empirical evidence in the mobile technology literature regarding users' intention to use mobile technology (Au & Kauffman, 2008; Mallat, 2007; Ondrus & Pigneur, 2006). Users will use m-payment systems when they find the system to be useful for their transaction needs or financial issues. Therefore, we hypothesize that perceived usefulness will exert a positive effect on the intention to use m-payment.

**H8.** Perceived usefulness will have a positive effect on the intention to use m-payment.

### 3.5. Early adopter and late adopter

Not all individuals in a society adopt an innovation simultaneously. Rather, they tend to adopt it at different periods, and they may be classified into different adopter categories on the basis of when they first begin to use the innovation (Rogers, 1995). In this study, we classified mobile payment users into two types – early adopters and late adopters – on the basis of the timing and behavioral characteristics of new technology adoption. Early adopters actively engage in information seeking to learn more about the benefits of using new technology (Hong & Zhu, 2006). An assessment and evaluation of the information obtained manifests itself in the form of beliefs regarding the new technology. Early adopters often function as opinion leaders who can encourage others to adopt the innovation by providing evaluative information (Rogers, 1995). Early adopters have a shorter adoption-decision span than late adopters. Thus, the first individuals to adopt a new technology do so not only because they become aware of the innovation somehow sooner than their peers, but also because they require less time to move from a knowledge phase to a decision phase (Hong & Zhu, 2006). Based on these observations, we infer that the proposed external constructs have different effects on the belief constructs of m-payment, depending on the m-payment user types. Therefore, we proposed the following hypotheses:

**H9a.** The effect of personal innovativeness on the perceived ease of use of m-payment depends on m-payment user types.

**H9b.** The effect of m-payment knowledge on the perceived ease of use of m-payment depends on m-payment user types.

**H9c.** The effect of mobility on the perceived ease of use and perceived usefulness of m-payment depends on m-payment user types.

**H9d.** The effect of reachability on the perceived ease of use and perceived usefulness of m-payment depends on m-payment user types.

**H9e.** The effect of compatibility on the perceived ease of use and perceived usefulness of m-payment depends on m-payment user types.

**H9f.** The effect of convenience on the perceived ease of use and perceived usefulness depends on m-payment user types.

**H9g.** The effect of perceived ease of use on the perceived usefulness and intention to use m-payment depends on m-payment user types.

**H9h.** The effect of perceived usefulness on the intention to use m-payment depends on m-payment user types.

## 4. Research methods

### 4.1. Construct measurement

Based on our review of the previous related literature and the comments gathered from our interviews, we constructed our survey instrument. We utilized a multiple-item method, in which each item was measured on a five-point Likert scale from strongly disagree to strongly agree. The items in our survey instrument were developed either by adapting the existing measures validated by other researchers (e.g., mobility, reachability-related factors) or by converting the definitions of the constructs into a questionnaire format (e.g., m-payment knowledge). The survey items are shown in the [Appendix](#).

The initial version of our survey instrument was subsequently refined via pretesting with a few professors, each with significant expertise in the study of mobile commerce. The instrument was then further pilot-tested with 15 respondents who are heavy mobile services users. The multiple phases of instrument development resulted in a significant degree of refinement and restructuring of the survey instrument, as well as the establishment of the initial face validity and internal validity of the measures ([Nunnally, 1978](#)).

### 4.2. Data collection procedure

The survey was conducted over the course of 12 weeks through visiting schools, universities, companies, research institutes, and Internet cafes, as well as e-mail surveys and interviews in Korea from February through May, 2009. To ensure that the measured beliefs were based on direct behavioral experience with the object, only responses from those who had previously used the mobile payment were included in our analysis. Among the 1700 questionnaires distributed, 360 questionnaires of those with experience of mobile payments were initially collected for input. Later, approximately one-fourth of the collected questionnaires were dropped due to missing data or invalid responses. Finally, 269 questionnaires were ultimately utilized for empirical analysis.

## 5. Empirical analysis

Descriptive statistics were used for the demographic analysis of the samples. The reliability and validity were measured using the Cronbach's alpha in order to assess the internal consistency of the construct measurement. Structural Equation Modeling (SEM) was applied using Amos 5.0 software package to conduct hypothesis testing (SEM) of the proposed research model. The SEM is use-

ful for the evaluation of the casual relationship between variables as well as the compatibility of the research model.

### 5.1. Demographic analysis

A total number of 269 responses were utilized in the analysis. The demographic profile of the respondents is shown in [Table 1](#). With regard to gender, males dominated (59.9%) over females (40.1%). In terms of age, the respondents are roughly evenly distributed from 20 to 40 years old. With regard to education, the majority were at least university graduates or equivalent (about 64% including the postgraduates).

With regard to profession, company employees constitute the majority, at 50%, whereas students constitute 28% of the respondents. Of those who are working, approximately 15% earn an average annual income of more than \$50,000. Respondents with earnings between \$30,000–50,000 constitute approximately 30% of the total respondents. According to annual income and educational levels, the majority of the respondents appear to belong to the middle class of Korean society (Korea National Statistical Office, 2002). The vast majority of respondents utilize m-payment 1–3 times per month (81%) and have more than 2 years of mobile payment experience (60% including categories with over 3 years). With regard to the primary reason for using m-payment, the majority of the respondents consider ease of transaction to be the most popular primary reason (41%), followed by “always carry” (32%) and “easier access than cash” (23%). The number of early adopters (44%) and the number of late adopters (56%) are roughly balanced.

### 5.2. Reliability and validity analysis

Prior to the data analysis, the measurement instruments were evaluated for reliability. This was done to determine the degree to which the observed variables measured the “true” value, and whether they were “error free.” Thus, the constructs were tested for reliability, using Cronbach's alpha test. [Nunnally \(1978\)](#) suggested that the score for each construct should be greater than 0.6 to be considered reliable. As shown in [Table 2](#), the Cronbach's alpha (reliability) ranges from 0.747 to 0.907. Because the overall reliability of measurement was above 0.7, the measurement instrument was shown to have a sufficient internal consistency. As a result, the data were found to be appropriate for further analysis.

In an effort to test for the convergent and discriminant validity of the constructs, factor analysis with varimax rotation was employed. The Kaiser-Meyer-Olkin measure of sampling adequacy (MSA) was found to be 0.920. Thus, the application of factor analysis was deemed appropriate. According to [Hair, Anderson, Tatham, and Black \(1998\)](#), in order to determine the minimum loading necessary to include an item in its respective construct, variables with loading greater than 0.3 were considered significant; loading greater than 0.4, more important; and loadings of 0.5 or greater were quite significant. Thus, this study accepts items with loading of 0.5 or greater. Two rounds of factor analyses were conducted. The initial solution suggested that nine factors could be extracted, and thus, Varimax rotation with factor loadings was then generated. A total of 9 factors with Eigen values greater than 1.0 were identified. The 9 factors accounted for approximately 76% of the total variance.

### 5.3. Research model evaluation

We conducted the covariance structure analysis using Amos 5.0 software to test the hypotheses. The measures of overall goodness-of-fit for the research model are shown in [Table 3](#). Absolute fit measures evaluate the overall suitability of the model through

**Table 1**  
Demographic profile of respondents.

Division		Frequency	Percent (%)	Division		Frequency	Percent (%)
Age	Under 19	9	3.3	Gender	Male	161	59.9
	20–25	65	24.2		Female	108	40.1
	26–30	79	29.4		Total	269	100.0
	31–40	84	31.2	Earnings (\$)	Less than 10,000	79	29.4
	41 or older	32	11.9		10,000–30,000	67	24.9
Education	Total	269	100.0		30,000–50,000	83	30.9
	Under high school	7	2.6		50,000 or more	40	14.9
	High school graduate	5	1.9		Total	269	100.0
	University student	81	30.1	M-payment use frequency per month	1–3 times	218	81.0
	University graduate	121	45.0		4–10 times	36	13.4
	Postgraduate	54	20.1		11–20 times	12	4.5
	Other	1	0.4		More than 21 time	3	1.1
Occupation	Total	269	100.0	Period of m-payment use	Less than 1 year	58	21.6
	Entrepreneur	16	5.9		1–2 years	60	22.3
	Public servant	12	4.5		2–3 years	69	25.7
	Company salaried employee	136	50.6		Over 3 years	82	30.5
	Waged worker	10	3.7	Primary reason for use	Always carry	87	32.3
	Student	75	27.9		Easier access than cash	63	23.4
	Housewife	5	1.9		Ease of transaction	110	40.9
	Researcher	7	2.6		Quick access to account	9	3.3
	Retiree	1	0.4	M-payment users	Early adopter	118	43.9
	Other	7	2.6		Late adopter	151	56.1
	Total	269	100.0		Total	269	100.0

**Table 2**  
Results of reliability and validity analysis.

Items	Factors group									Reliability
	1	2	3	4	5	6	7	8	9	
PEU2	<b>.797</b>	.187	.156	–.052	.127	.141	.174	.127	.066	.907
PEU3	<b>.781</b>	.195	.154	.099	.096	.104	.145	.081	.075	
PEU4	<b>.755</b>	.115	.092	.275	.094	.145	.112	.070	.118	
PEU1	<b>.744</b>	.101	.263	.116	.128	.213	.147	.046	.128	
PEU5	<b>.727</b>	.235	.092	.268	.058	.065	.120	.190	.097	
BIU1	.049	<b>.824</b>	.113	.102	–.004	–.041	.155	–.006	–.046	.868
BIU3	.273	<b>.758</b>	.076	.095	.124	.172	.082	.111	.177	
BIU2	.265	<b>.745</b>	.017	.025	.139	.166	.062	.114	.265	
BIU4	.211	<b>.722</b>	.107	.043	.142	.272	.025	.063	.219	
MOB2	.151	.085	<b>.834</b>	.197	.046	.144	.081	.109	.050	.842
MOB3	.195	.147	<b>.763</b>	.244	.126	–.002	.027	.288	–.057	
MOB1	.196	.030	<b>.758</b>	.077	.254	.177	–.029	–.017	.240	
CON1	.222	.075	.165	<b>.719</b>	.305	.242	.101	.106	.161	.898
CON3	.133	.138	.383	<b>.683</b>	.210	.118	.113	.176	.157	
CON2	.132	.085	.356	<b>.672</b>	.301	.191	.180	.161	.200	
CON4	.398	.088	.140	<b>.630</b>	.233	.219	.084	.037	.087	
COM2	.135	.126	.114	.165	<b>.861</b>	.158	.051	.036	.017	.874
COM1	.130	.072	.066	.263	<b>.831</b>	.097	.124	.149	.072	
COM3	.133	.138	.287	.223	<b>.719</b>	.115	.151	.169	.074	
MPK2	.167	.122	.109	.222	.120	<b>.809</b>	.078	.038	.156	.826
MPK1	.155	.087	.108	.087	.134	<b>.736</b>	.302	.036	–.022	
MPK4	.171	.220	.113	.152	.111	<b>.729</b>	.237	.079	.089	
MPK3	.268	.392	–.007	.382	.143	<b>.617</b>	.139	–.004	–.282	
INN2	.096	.203	.019	.070	.023	.094	<b>.876</b>	.064	–.016	.817
INN1	.231	.034	.014	.097	.190	.158	<b>.781</b>	.021	.075	
INN3	.165	.054	.076	.104	.069	.297	<b>.728</b>	.061	.044	
REA1	.216	.039	.215	.034	.103	.078	.102	<b>.838</b>	.075	.747
REA3	.078	.185	.164	.400	.325	.064	.028	<b>.618</b>	–.010	
PUN3	.195	.372	.139	.194	.117	.189	.135	.088	<b>.628</b>	
PUN2	.372	.385	.121	.257	.042	–.012	.023	–.011	<b>.596</b>	
Eigen value	12.201	2.647	2.222	1.757	1.416	1.275	.986	.919	.767	
Accumulative distribution (%)	38.129	46.402	53.345	58.835	63.259	67.243	70.326	73.199	75.595	

Note: INN; innovativeness, MPK; m-payment knowledge, MOB; mobility, REA; reachability, COM; compatibility, CON; convenience, PEU; perceived ease of use, PUN; perceived usefulness, BIU; behavioral intention to use m-payment.  
Bold face means 'significant loadings'.

Chi-square, GFI (Goodness of Fit Index), RMR (Root Mean square Residual), and RMSEA (Root Mean Square Error of Approximation). Incremental fit measures evaluate the fitness of the research model via NFI (Normed Fit Index), CFI (Comparative Fit Index), and TLI (Turker–Lewis Index). Parsimonious fit measures evaluate the fitness level of the research model through NC (Normed Chi-square).

The fitness of the research model from the covariance structure modeling analysis is presented in Table 3. With regard to the results of our analysis of the fitness, the  $p$  value for  $\chi^2$  appeared as 0.000, which did not satisfy the standard. However, as the result is affected by the sample size and complexity of the model sensitively, it was determined that it was more proper to evaluate the

**Table 3**  
Measures of model fitness.

Chi-square	DF	p-Value	CMIN/DF	RMR	GFI	NFI	CFI	TLI	RMSEA
436.300	302	.000	1.445	.043	.900	.913	.971	.964	.041

fitness by means of RMR, GFI, NFI, CFI and RMSEA. The comparison of all fit indices with their corresponding recommended values provided evidence of acceptable model fit (NS = 1.445, RMR = 0.043, GFI = 0.900, NFI = 0.913, CFI = 0.971, TLI = 0.964, and RMSEA = 0.041). Thus, we move to the final step of the study, the test of the hypotheses.

#### 5.4. Hypotheses testing using all data

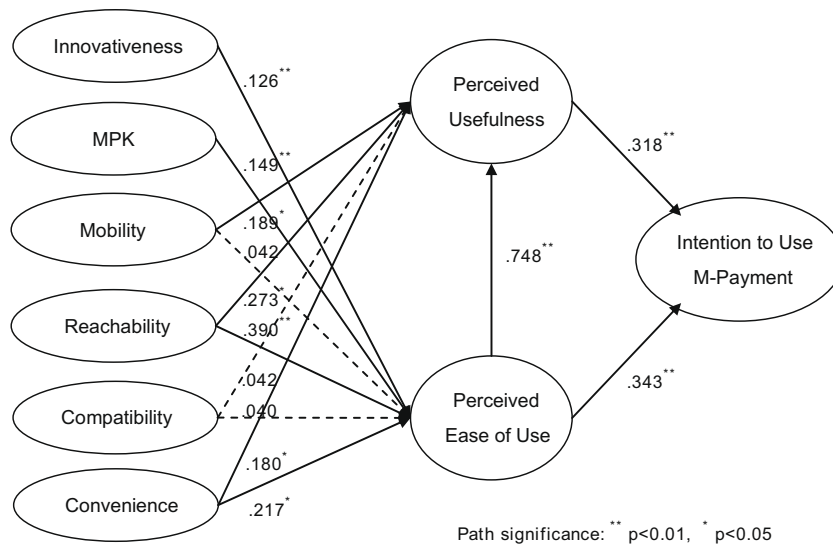
In an effort to determine the effects of m-payment system characteristics and individual differences on the perceived ease of use, usefulness, and intention to use m-payment, we conducted covariance structure modeling analysis, the test results of which are shown in Fig. 2 and Table 4.

First, personal innovativeness is associated positively with perceived ease of use at a significance level of 0.01; therefore, we concluded that Hypothesis 1 was supported. In addition, individual m-payment knowledge (MPK) is also related positively to perceived

ease of use at a significance level of 0.05; therefore, Hypothesis 2 is supported.

Hypotheses 3–6 investigated the causal role of m-payment system characteristics (mobility, reachability, compatibility, and convenience) on perceived ease of use and perceived usefulness. Hypothesis 3a and 3b specifically tested the role of mobility as a predictor of perceived ease of use and perceived usefulness. As had been suggested, mobility was indeed associated with perceived usefulness at a confidence level of 0.05. However, Hypothesis 3a was not supported ( $p = 0.678$ ). Similarly, Hypotheses 4a and 4b were concerned about the impact of reachability on perceived ease of use and perceived usefulness. The results showed that user's reachability has a significant effect on both constructs; therefore, Hypotheses 4a and 4b were supported.

Hypotheses 5a to 5b assessed the effect of compatibility on perceived ease of use and perceived usefulness. To our surprise, both hypotheses were not supported. Hypotheses 6a to 6b assessed the effect of convenience on perceived usefulness and perceived ease



**Fig. 2.** Hypothesis test.

**Table 4**  
Hypothesis test result.

Attributes	Estimate	S.E.	C.R.	p	Hypothesis status
Innovativeness → Perceived ease of use	0.126	0.048	2.647	0.008	H1 Supported
MPK → Perceived ease of use	0.149	0.049	3.056	0.002	H2 Supported
Mobility → Perceived ease of use	0.042	0.102	0.416	0.678	H3a Not supported
Mobility → Perceived usefulness	0.189	0.094	2.009	0.045	H3b Supported
Reachability → Perceived ease of use	0.390	0.123	3.161	0.002	H4a Supported
Reachability → Perceived usefulness	0.273	0.126	2.164	0.030	H4b Supported
Compatibility → Perceived ease of use	0.040	0.07	0.570	0.569	H5a Not supported
Compatibility → Perceived usefulness	0.042	0.067	0.624	0.533	H5b Not supported
Convenience → Perceived ease of use	0.217	0.097	2.242	0.025	H6a Supported
Convenience → Perceived usefulness	0.180	0.09	1.991	0.046	H6b Supported
Perceived ease of use → Perceived usefulness	0.748	0.091	8.226	0.000	H7a Supported
Perceived ease of use → Intention to use mobile payment	0.343	0.105	3.274	0.001	H7b Supported
Perceived usefulness → Intention to use mobile payment	0.318	0.103	3.096	0.002	H8 Supported



**Table 5**

Mobile payment user classification.

<i>I am willing to take risk</i>	Early adopter
<i>I am interested in new technology</i>	
<i>I tend to be first in buying new products</i>	
<i>I am kind-of cosmopolitan</i>	
<i>If someone else did it first, it might be all right</i>	
<i>Adopting may be an economic necessity</i>	Late adopter
<i>Adopting may be a result of peer pressure</i>	
<i>I still feel uncertain about new technology</i>	
<i>Everyone else has done it, should I?</i>	
<i>I am suspicious of changes</i>	

of use. The results showed that convenience has a significant positive impact on both constructs at a confidence level of 0.05. Additionally, perceived ease of use was positively associated with perceived usefulness at a significance level of 0.01.

At last, Hypotheses 7b and 8 assessed the manner in which perceived ease of use and perceived usefulness are associated with the intention to use m-payment. The results indicated that both perceived ease of use and perceived usefulness exerted significant effect on the intention to use m-payment at a significance level of 0.01.

### 5.5. Hypotheses testing by mobile payment user types

In this study, m-payment users were classified into two types, early adopters and late adopters, on the basis of their responses to the new technology. In our survey, respondents were asked to select the statement that best described them. Based on their responses, the responders were classified as one of the two user types, as is shown in Table 5.

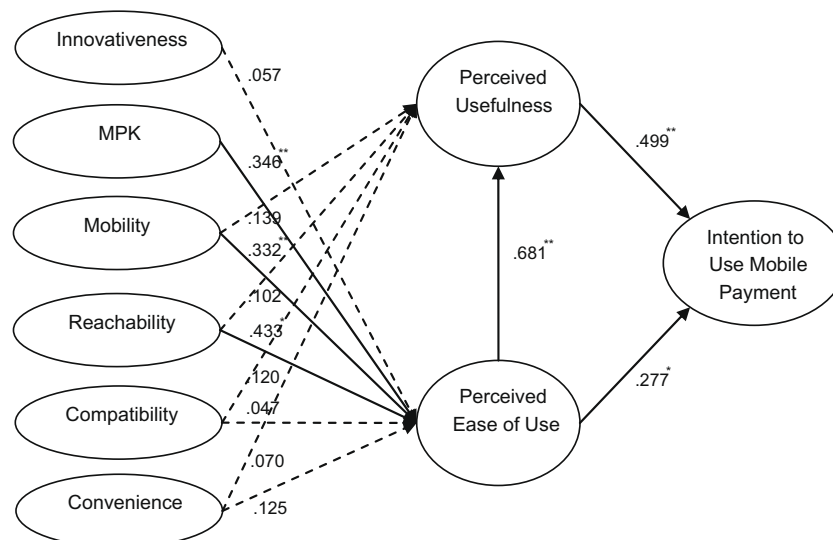
The results of our m-payment classifications showed that 43.9% of respondents considered themselves early adopters while the majority (56.1%) referred themselves as late adopters. To investigate the differences in the demographic characteristics of these two user groups, their age and education level were analyzed. For early adopters, 18.6% of the survey respondents are in the age range of 20–25 years, 33.1% 31–40 years, and 36.4% 26–30 years. 55.1% of the survey respondents are university graduates, and 24.6% university students. For late adopters, 23.8% of

the survey respondents are in the age range of 26–30 years, 27.8% 20–25 years, and 29.1% 31–40 years. 35.1% of the survey respondents are university graduates, and 33.8% university students. The characteristics of the two groups are consistent with the overall sample characteristics. The difference in the age between the two groups was not statistically significant ( $F = 6.320$ ,  $p = 0.013$ ;  $t = 1.011$ ,  $p = 0.313$ ). The difference in the education level between the two groups was also not statistically significant ( $F = 10.552$ ,  $p = 0.001$ ;  $t = 1.278$ ,  $p = 0.202$ ). Based on these observations, individual differences and m-payment system characteristics were further analyzed for these two types. The path analysis results for m-payment user types are shown in Fig. 3 and Fig. 4, and the detailed test results for the hypotheses are as follows.

First of all, in the case of early adopters who represent 43.9% of all respondents, none of the m-payment system characteristics were significantly related with perceived usefulness. On the other hand, perceived ease of use was explained by m-payment knowledge, mobility, and reachability. On the contrary, in the case of late adopters, reachability and convenience were related positively to perceived usefulness. Moreover, perceived ease of use was positively related to personal innovativeness and reachability. Besides, in both cases perceived ease of use was positively related to perceived usefulness. Perceived ease of use and perceived usefulness were positively related to the intention to use m-payment. In an effort to verify the differences in m-payment user types, loose cross validation was performed to determine the cross validation through the par value of each group matrix. The results of our analysis are shown in Table 6. The results suggest that there is a significant difference between the two groups in the effect of m-payment knowledge, mobility, and innovativeness on perceived ease of use. Furthermore, the results also indicate that there is a significant difference between the two groups in the effect of convenience and reachability on perceived usefulness.

## 6. Discussions

In this empirical study, we analyzed users' acceptance of m-payment. In order to adapt the TAM to the mobile payment context, we extended it with two user-centric factors and four system characteristics. Moreover, in order to further our understanding of

**Fig. 3.** Test result for early adopters.

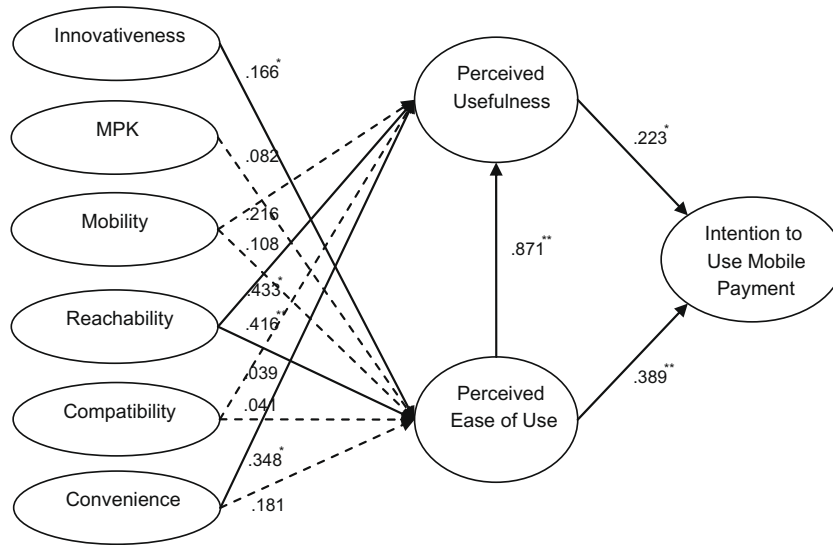


Fig. 4. Test result for late adopters.

the users' adoption behavior, we categorized m-payment users into early and late adopters and investigated the user-group level behavior.

Our results show that users with highly innovative characteristics found m-payment to be easy to use. M-payment users with significant m-payment knowledge do not have difficulty in adapting to m-payment. Among the four system characteristics, reachability and convenience have significant effects on perceived ease of use and perceived usefulness. It is noted that among the four system characteristics reachability is the most important predictor of perceived ease of use and perceived usefulness. Compatibility does not have an effect on either perceived ease of use or perceived usefulness. All in all, perceived usefulness was explained by mobility, reachability, convenience and perceived ease of use. Compared to traditional offline payment, the growth opportunities of m-payment abound. As telecommunications technologies advance, m-payment service providers can enhance these system characteristics without additional costs by taking advantage of the declining cost of technologies, thus resulting in greater adoption by users.

The results indicated that both perceived ease of use and perceived usefulness exerted significant effect on the intention to use m-payment. Among the variables under study, perceived ease of use is the greatest predictor of perceived usefulness. The result shows that the easier to use the users feel m-payment is, the more useful they feel m-payment is. Perceived usefulness in turn has a positive effect on the intention to use m-payment. For users to continue to use m-payment, m-payment services should be designed and developed to deliver value to them. The usefulness can be further enhanced by providing better m-payment services without increasing the complexity of the m-payment services.

For early adopters, the level of m-payment knowledge is crucial to the users' perceived easy to use of m-payment. This can be explained by the fact that the knowledge of m-payment gives early adopters confidence to try complex m-payment features in a variety of usage contexts. Moreover, early adopters consider mobility and reachability necessary for the perceived ease to use of m-payment. However, no m-payment system characteristics affect the perceived usefulness of m-payment. This result

Table 6

Hypothesis test results by mobile payment user type.

Model constructs			Early adopter			Late adopter			Cross validity C.R.
			Estimate	C.R.	Label	Estimate	C.R.	Label	
Perceived ease of use	←	M-payment knowledge	0.346**	4.024	Par_20	0.082	1.569	Par_92	2.616*
	←	Mobility	0.332*	1.969	Par_21	0.108	0.875	Par_93	2.105*
	←	Convenience	0.125	0.708	Par_27	0.181	1.592	Par_99	1.457
	←	Compatibility	0.047	0.451	Par_28	0.041	0.504	Par_100	0.041
	←	Reachability	0.433*	2.348	Par_29	0.416*	2.490	Par_101	0.068
	←	Innovativeness	0.057	0.766	Par_31	0.166*	2.585	Par_103	2.106*
Perceived usefulness	←	Mobility	0.139	0.955	Par_30	0.216	1.544	Par_102	0.382
	←	Compatibility	0.120	1.258	Par_25	0.039	0.401	Par_97	1.165
	←	Convenience	0.070	0.614	Par_26	0.348*	2.554	Par_98	2.815*
	←	Reachability	0.102	0.620	Par_24	0.433*	2.010	Par_96	5.854*
	←	Perceived ease of use	0.681**	6.416	Par_32	0.871**	5.474	Par_104	0.994
Intention to use mobile payment	←	Perceived ease of use	0.277*	1.986	Par_19	0.389**	2.739	Par_91	0.515
	←	Perceived usefulness	0.499*	2.395	Par_18	0.223*	2.098	Par_90	1.181

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

indicates that when it comes to the usefulness of m-payment, early adopters cannot expect much of the features of the new m-payment systems. The result may be attributable to the fact that when the early adopters started to use m-payments, the systems were in the early stage of diffusion and provided only limited functions to users. For late adopters, however, reachability and innovativeness are important predictors of the perceived ease of use of m-payment. The effect of reachability on the perceived ease of use can be attributed to the fact that late adopters are relatively passive and cautious in technology adoption and think m-payment systems to be free of effort if m-payment service providers make m-payment services more reachable to others. The effect of personal innovativeness on the perceived ease of use indicates that non-innovative late adopters may need extended help in using the m-payment systems. Additionally, another difference between early adopters and late adopters is the effect of convenience on the perceived usefulness. Unlike early adopters, late adopters think the provision of convenience to be essential for the usefulness.

## 7. Conclusion

The main objective of our study was to determine the factors that affect the use of m-payment. To achieve our objective, a research model was proposed which consists of six external variables (two individual differences and four system characteristics), two belief variables (perceived usefulness and perceived ease of use), and one dependent variable (the intention to use m-payment).

The major contributions of this study are as follows. First, this study successfully extended TAM in the mobile payment context, which is different from the context of other information systems. This study incorporated the system characteristics and individual differences which pertain to m-payment, but were overlooked in the previous m-payment studies. The findings of this study have external validity owing to the representative demographics of the respondents. The validated instrument will be useful to researchers in further developing and refining m-payment research models, as well as to managers in developing effective m-payment service systems.

The results of empirical analysis show that perceived ease of use and perceived usefulness were determined to be significant antecedents of the intention to use m-payment. Individual differences, convenience, and reachability are critical determinants of the perceived ease of use of m-payment. Compatibility has an insignificant effect on perceived usefulness and perceived ease of use. M-payment knowledge has a greater effect on perceived ease of use than does personal innovativeness.

The in-depth analysis of m-payment user types demonstrated that in the case of early adopters, the m-payment system characteristics have no effect on the perceived usefulness, as early adopters usually cannot expect much of the useful features from the new technology. However, mobility and reachability affected the ease of use of m-payment, which in turn increase the intention to use m-payment. On the other hand, for late adopters, reachability affects both the perceived ease of use and usefulness of m-payment. Unlike early adopters, late adopters perceive m-payment to be useful if m-payment is reachable and convenient. Moreover, innovative late adopters perceive m-payment to be easier to use than non-innovative late adopters.

For m-payment service providers, the results provide invaluable information on the user behavior. For users to continue to use m-payment, m-payment services should be designed and developed to deliver value to them. As telecommunications technologies ad-

vance, m-payment service providers can enhance the system characteristics without additional costs by taking advantage of the declining cost of technologies, thus resulting in greater usefulness by users. The usefulness can be further enhanced by providing better m-payment services without increasing the complexity of the m-payment services.

There exist clear differences between the two user groups. M-payment service providers need to apply different business models and strategies depending on the user groups and diffusion stages of m-payment services. At the early diffusion stage of the m-payment services, the service providers need to focus on perceived ease of use of early adopters. When the m-payment service market gets mature and competitive, they need to provide a variety of service options to accommodate both the early and late adopters.

## Implications and further studies

The findings of this study have significant implications for the development and refinement of mobile payment services. Considering significant time and money required for the development of mobile payment systems, it is of paramount importance to ensure that mobile users will actually use m-payment. In order to achieve this goal, attention must be paid to the development of appropriate m-payment services business model and marketing strategies as well as systems design. From the practical perspective, m-payment users can be classified as either early adopters or late adopters. Individual differences and m-payment system characteristics affect differently the perceived usefulness and perceived ease of use of these two types of users. Our findings will also help the service providers invest appropriate time, effort, and money in the development and provisions of services. From the managerial perspective, the findings of this research should also prove very helpful to a number of stakeholders in mobile commerce such as merchants, mobile network operators, banks, designers of m-payment systems, and consumers of m-payment services.

From the academic perspective, we attempted to classify external variables into consumer-centric (individual differences) and technology-related (system characteristics) constructs, and integrated them into the proposed research model. In the future, when studying new constructs, a researcher should be able to readily relate them to one of the constructs according to their characteristics. In addition, this study guides directions for future research regarding the classification of m-payment user types. While this study identified the two user types, future research may well focus on more adequate and acceptable classifications of m-payment users.

However, this study also has limitations. First, we did not incorporate actual usage behavior into the proposed model. However, substantial empirical support exists regarding the causal link between intention and usage behavior (Venkatesh & Davis, 2000). Second, there may exist other individual difference and system characteristics variables that can affect the intention to use m-payment. Other individual difference variables for future studies include cognitive activity and self-efficacy. Other system characteristics suggested in the previous studies include localization, accessibility, personalization, and ubiquity. Finally, the criteria for the user classification may be further elaborated, and other moderating variables can be investigated in future studies. Despite the above-mentioned limitations, we believe that this paper furthers our understanding of the intention to use m-payment, and will provide a useful set of guidelines for the provision of m-payment services to different m-payment user groups.

## Appendix A

1. Survey items for MPS characteristics	
<i>Mobility</i>	
MOB1	I believe mobile payment is independent of time
MOB2	I believe mobile payment is independent of place
MOB3	I can use mobile payment anytime while traveling
<i>Reachability</i>	
REA1	In general, I would be always reachable by others through phone call
REA2*	Mobile payment can be connected regardless of the location
REA3	It is always possible for my bank to contact me when it is needed
<i>Compatibility</i>	
COM1	I believe mobile payment is compatible with existing technology
COM2	I believe mobile payment is compatible with other mobile services
COM3	I believe mobile payment is compatible with my daily routine tasks
<i>Convenience</i>	
CON1	Mobile payment is convenient because the phone is usually with me
CON2	Mobile payment is convenient because I can use it anytime
CON3	Mobile payment is convenient because I can use it in any situation
CON4	Mobile payment is convenient because mobile payment service is not complex
2. Survey items for individual differences	
<i>Personal innovativeness</i>	
INN1	I know more about new products before other people do
INN2	I am usually among the first to try new products
INN3	New products excite me
<i>M-payment knowledge</i>	
MPK1	I enjoy purchasing products via mobile devices
MPK2	I use Internet banking, credit cards, or mobile payment to make purchases
MPK3	I mostly use mobile payment when purchasing goods or services via mobile phone
MPK4	I would be confident to use m-banking for financial transactions
<i>Perceived ease of use</i>	
PEU1	Learning to use the mobile payment is easy for me
PEU2	My interaction with mobile payment procedure would be clear and understandable
PEU3	It would be easy for me to become skillful at using the mobile payment
PEU4	I would find the mobile payment easy to use
PEU5	I would find a mobile payment procedure to be flexible to interact with
<i>Perceived usefulness</i>	
PUN1	Using mobile payment would enable me to pay more quickly
PUN2	Using mobile payment makes it easier for me to conduct transactions
PUN3	I would find mobile payment a useful possibility for paying

## Behavior intention

BIU1	Now I pay for purchases with a mobile phone
BIU2	Assuming that I have access to the m-payment, I intend to use it
BIU3	During the next six (6) months I intend to pay for purchases with a mobile phone
BIU4	Five (5) years from now I intend to pay for purchases with a mobile phone

\* Deleted due to a cross-factor loading.

## References

- Agarwal, R., & Prasad, J. (1999). Are individual differences germane to the acceptance of new information technologies? *Decision Sciences*, 30(2), 361–391.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50, 179–211.
- Ankar, B., & D'Incau, D. (2002). Value creation in mobile commerce. Findings from a consumer survey. *JITTA: Journal of Information Technology Theory & Application*, 4(1), 43–65.
- Antovski, L., & Gusev, M. (2003). M-Payments. *Paper presented at the 25th International Conference of Information Technology Interfaces*, Cavtat, Croatia.
- Au, Y. A., & Kauffman, R. J. (2008). The economics of mobile payments: Understanding stakeholder issues for an emerging financial technology application. *Electronic Commerce Research and Applications*, 7, 141–164.
- Berry, L. L., Seiders, K., & Grewal, D. (2002). Understanding service convenience. *Journal of Marketing*, 66(3), 1–17.
- Blake, B. F., Neuendorf, K. A., & Valdeserri, C. M. (2003). Innovativeness and variety of internet shopping. *Internet Research*, 13(3), 156–169.
- Chang, M., Cheung, W., & Lai, V. (2005). Literature derived reference models for the adoption of online shopping. *Information & Management*, 42(4), 543–559.
- Chen, J. J., & Adams, C. (2005). User acceptance of mobile payments: A theoretical model for mobile payments. *Paper presented at the 5th International Conference on Electronic Business*, Hong Kong, December, 5–9.
- Chen, C., Czerwinski, M., & Macredie, R. (2000). Individual differences in virtual environments – Introduction and overview. *Journal of the American Society for Information Science*, 51(6), 499–507.
- Cheong, J. H., Park, M. C., & Hwang, J. H. (2004). Mobile payment adoption in Korea: Switching from credit card. *Paper presented at the ITS 15th Biennial Conference*, Berlin, Germany, September, 4–7.
- Clarke, I. (2001). Emerging value propositions for M-commerce. *Journal of Business Strategies*, 18(2), 133–149.
- Coursaris, C., & Hassanein, K. (2002). Understanding M-commerce a consumer centric model. *Quarterly Journal of Electronic Commerce*, 3(3), 247–271.
- Crespo, Á. H., & del Bosque, I. R. (2008). The effect of innovativeness on the adoption of B2C E-commerce. A model based on the theory of planned behaviour. *Computers in Human Behavior*, 24(6), 2830–2847.
- Dahlberg, T. (2007). Past, present and future of mobile payments research: A literature review. *Electronic Commerce Research and Applications*, 10(10), 16–21.
- Dahlberg, T., Mallat, N., Penttinen, E., & Sohlberg, P. (2002). What characteristics of mobile payment solutions make them valuable to consumers? *Proceedings of the global information technology management conference*, New York, USA.
- Dahlberg, T., Mallat, N., & Öörni, A. (2003a). Consumer acceptance of mobile payment solutions – Ease of use, usefulness and trust. *Paper presented at the 2nd International Conference on Mobile Business*, Vienna, Austria, June, 23–24.
- Dahlberg, T., Mallat, N., & Öörni, A. (2003b). Trust enhanced technology acceptance model-consumer acceptance of mobile payment solutions. *Paper presented at the 2nd Mobility Roundtable*, Stockholm, Sweden, May, 22–23.
- Davis, F. D. (1986). A technology acceptance model for empirically testing new end-user information system: Theory and results. *Doctoral Dissertation*, Sloan School of Management, Massachusetts Institute of Technology.
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 318–330.
- Davis, F. D. (1993). User acceptance of information technology: System characteristics, user perception, and behavior impacts. *International Journal of Man Machine Studies*, 38(3), 475–487.
- Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, 35(8), 982–1003.
- Dewan, S. G., & Chen, L. D. (2005). Mobile payment adoption in the USA: A cross-industry, cross-platform solution. *Journal of Information Privacy and Security*, 1(2), 4–28.
- Dholakia, N., & Rask, M. (2002). Configuring mobile commerce portals for customer retention. *Working paper of Research Institute for Telecommunications and Information Marketing (RITIM)*, Denmark.
- Dillon, A., & Watson, C. (1996). User analysis in HCI-the historical lessons from individual difference research. *International Journal of Human-Computer Studies*, 45(6), 619–637.



- Ding, M. S., & Hampe, J. F. (2003). Reconsidering the challenges of M-payments: A roadmap to plotting the potential of the future M-commerce market. *Paper presented at the 16th Bled eCommerce Conference*, Bled, Slovenia, June, 9–11.
- Ding, X., Ijima, J., & Ho, S. (2004). *Unique features of mobile commerce*. Tokyo 152-8552, Japan: Graduate School of Decision Science and Technology, TITECH.
- Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.
- Guo, W. (2008). Design of architecture for mobile payments system. *Paper presented at the Chinese Control and Decision Conference (CCDC 2008)* (pp. 1732–1735). July.
- Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis*. Englewood Cliffs, NJ: Prentice Hall International.
- Hong, W., & Zhu, K. (2006). Migrating to internet-based e-Commerce. Factors affecting e-Commerce adoption and migration at the firm level. *Information and Management*, 43, 204–221.
- Jih, W.-J. (2007). Effects of consumer-perceived convenience on shopping intention in mobile commerce. An empirical study. *International Journal of E-Business Research*, 3(4), 33–48.
- Juniper Research. (2008). Mobile payment markets digital & physical goods, 2008–2013. *Juniper Research*.
- Karahanna, E., Ahuja, M., Srite, M., & Galvin, J. (2002). Individual differences and relative advantage: The case of GSS. *Decision Support Systems*, 32(4), 327–341.
- Karnouskos, S., & Fokus, F. (2004). Mobile payment: A journey through existing procedures and standardization initiatives. *IEEE Communications Surveys and Tutorials*, 6(4), 44–66.
- Lim, A. S. (2007). Inter-consortia battles in mobile payments standardization. *Electronic Commerce Research and Applications*, 2(2), 15–23.
- Luarn, P., & Lin, H. H. (2005). Toward an understanding of the behavioral intention to use mobile banking. *Computers in Human Behavior*, 21(6), 873–891.
- Mallat, N. (2004). Theoretical constructs of mobile payment adoption. *Paper presented at the 27th Information Systems Research Seminar in Scandinavia (IRIS)*, Falkenberg, Sweden, August, 14–17.
- Mallat, N. (2007). Exploring consumer adoption of mobile payments – A qualitative study. *Journal of Strategic Information Systems*, 16, 413–432.
- Mallat, N., & Dahlberg, T. (2005). Consumer and merchant adoption of mobile payment solutions. *Managing business in a multi-channel world: Success factors for e-Business*. Hershey, PA 17033, USA: Idea Group Publishing.
- Mallat, N., Rossi, M., & Tuunainen, V.K. (2006). The impact of use situation and mobility on the acceptance of mobile ticketing services. In *Proceedings of the 39th Hawaii international conference on system sciences*. Hawaii.
- Manvi, S. S., Bhajantri, L. B., & Vijayakumar, M. A. (2009). Secure mobile payment system in wireless environment. In *Proceedings of the international conference future computer and communication (ICFCC 2009)* (pp. 31–35). April 3–5.
- Massoth, M., & Bingel, T. (2009). Performance of different mobile payment service concepts compared with a NFC-based solution. In *Proceedings of the 4th international conference internet and web applications and services (ICIW '09)* (pp. 205–210). May 24–28.
- May, P. (2001). *Mobile commerce: Opportunities, applications, and technologies of wireless business*. Cambridge University Press.
- Mohammadi, S., & Jahanshahi, H. (2008). A study of major mobile payment systems' functionality in Europe. In *Proceedings of the 11th international conference computer and information technology (ICIT 2008)* (pp. 605–610). December 24–27.
- Nelson, D. L. (1990). Individual adjustment to information-driven technologies: A critical review. *MIS Quarterly*, 14(1), 79–98.
- Ng-Kruelle, G., Swatman, P. A., Rebme, D. S., & Hampe, J. F. (2002). The price of convenience. Privacy and mobile commerce. *Quarterly Journal of Electronic Commerce*, 3(3), 273–285.
- Nohria, N., & Leestma, M. (2001). A moving target: The mobile-commerce customer. *Sloan Management Review*, 42(3), 104–115.
- Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.
- Obe, O. O., & Balogu, V. F. (2007). Practice, trends and challenges of mobile commerce in Nigeria. *Information Technology Journal*, 6(3), 448–456.
- Ondrus, J., Lyytinen, K., & Pigneur, Y. (2009). Why mobile payments fail? Towards a dynamic and multi-perspective explanation. In *Proceedings of the 42nd Hawaii international conference on system sciences (HICSS'09)* (pp. 1–10). Hawaii: IEEE Computer Society. January 5–8.
- Ondrus, J., & Pigneur, Y. (2006). Towards a holistic analysis of mobile payments: A multiple perspectives approach. *Electronic Commerce Research and Applications*, 5, 246–257.
- Perry, M., O'hara, K., Sellen, A., Brown, B., & Harper, R. (2001). Dealing with mobility: Understanding access anytime, anywhere. *ACM Transactions on Computer-Human Interaction*, 8(4), 323–347.
- Rahimian, V., & Habibi, J. (2008). MPaySmart: A customer centric approach in offering efficient mobile payment services. In *Proceedings of the Asia-Pacific services computing conference (APSCC'08)* (pp. 1038–1043). IEEE Computer Society. December 9–12.
- Rieh, S. Y. (2004). On the web at home: Information seeking and web searching in the home environment. *Journal of the American Society for Information Science and Technology*, 55, 743–753.
- Rogers, E. M. (1995). *Diffusion of innovations* (4th ed.). New York: The Free Press.
- Sun, H., & Zhang, P. (2006). The role of moderating factors in user technology acceptance. *International Journal of Human-Computer Studies*, 64(4), 53–78.
- Tariq, B. (2007). Exploring factors influencing the adoption of mobile. *Journal of Internet Banking and Commerce*, 12(3), 32–42.
- Torsten, J., Gerpott, A., & Kornmeier, K. (2009). Determinants of customer acceptance of mobile payment systems. *International Journal of Electronic Finance*, 3(1), 1–30.
- Valcourt, E., Robert, J. M., & Beaulieu, F. (2005). Investigating mobile payment: Supporting technologies, methods, and use. *Paper presented at the International Conference on Wireless and Mobile Computing, Networking and Communications*, Montreal, Canada, August, 22–24.
- Venkatesh, V. (2000). Determinants of perceived ease of use. Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information System Research*, 11(4), 342–365.
- Venkatesh, V., & Davis, F. D. (1996). A model of the antecedents of perceived ease of use: Development and test. *Decision Sciences*, 27(3), 451–481.
- Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, 46(2), 186–204.
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of IT: Toward a unified view. *MIS Quarterly*, 27(3), 425–478.
- Xu, G., & Gutierrez, J. A. (2006). An exploratory study of killer applications and critical success factors in M-commerce. *Journal of Electronic Commerce in Organizations*, 4(3), 63–79.
- Yi, M. Y., Fiedler, K. D., & Park, J. S. (2006). Understanding the role of individual innovativeness in the acceptance of IT-based innovations: Comparative analyses of models and measures. *Decision Sciences*, 37(3), 393–426.
- Zmijewska, A., Lawrence, E., & Steele, R. (2004a). Classifying M-payments – A user-centric model. *Paper presented at the 3rd International Conference on Mobile Business*, New York, USA, July, 12–13.
- Zmijewska, A., Lawrence, E., & Steele, R. (2004b). Towards understanding of factors influencing user acceptance of mobile payment systems. *Paper presented at the IADIS International Conference*, Madrid, Spain, October, 6–9.
- Zmud, R. V. (1979). Individual differences and MIS success: A review of the empirical literature. *Management Science*, 25(10), 966–979.