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Towards an understanding of the consumer acceptance of mobile wallet

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ABSTRACT

This study seeks to validate a comprehensive model of consumer acceptance in the context of mobile payment. It uses the unified theory of acceptance and use of technology (UTAUT) model with constructs of security, trust, social influence, and self-efficacy. Structural equation modeling is used to construct a predictive model of attitudes toward the mobile wallet. Individuals' responses to questions about attitude and intention to adopt/use a mobile wallet were collected and analyzed with various factors modified from UTAUT. While the model confirms the classical role of technology acceptance factors (i.e., perceived usefulness and ease of use are key antecedents to users' attitude), the results also show that users' attitudes and intentions are influenced by perceived security and trust. In the extended model, the moderating effects of demographics on the relations among the variables were found to be significant. The proposed model brings together extant research on mobile payment and provides an important cluster of antecedents to eventual technology acceptance via constructs of behavioral intention to use and actual system usage.

1. Introduction

Mobile payments have been in use for many years and have gained ground (Dahlberg, Mallat, Ondrus, & Zmijewska, 2008). The mobile wallet is a new application of mobile payment that has functionality to supplant a conventional wallet and more. A mobile wallet is a much-advanced versatile application that includes elements of mobile transactions, as well as other items one may find in a wallet, such as membership cards, loyalty cards and travel cards. It also stores personal and sensitive information like passports, credit card information, PIN codes, online shopping accounts, booking details and insurance policies that can be encrypted or password-protected. Mobile wallets have already become a mainstream phenomenon in Asia (Yang, 2005). One of the first carriers to launch a mobile wallet is NTT Docomo, which has already signed up more than 15 million subscribers (Jupiter Research, 2008). It uses its Felica system to allow those who carry compatible 3G handsets, like Fujitsu's F900iC and other models by NEC, Panasonic, Sharp, Mitsubishi and Sony Ericsson, to make payments using their handsets. A credit card-sized Sony smart card powers the system. It holds a chip which can be loaded with personal data. DoCoMo's mobile wallet service has become a *de facto* standard mobile payment system in Japan. The mobile wallet trend is slowly spreading westward, as players such as MasterCard and Nokia test mobile phone payments using MasterCard's PayPass contactless reader technology, combined with a chip embedded in a Nokia handset. According to Jupiter Research, a high-tech market research firm, as many as 25 million wireless phone subscribers in North America could be using their mobile phones as mobile wallets by 2011 (Jupiter Research, 2008).

As with many rollouts, a key problem is that there are still not enough places for consumers to use this technology, even though it has been available for over two years. About 100,000 terminals and readers have been deployed with retail merchants, not counting multiple brands of applications accepted at the same shop or restaurant. Other problems have to do with the technology. Mobile vendors have struggled over how to personalize phones over the air, as well how to enable a better experience for downloading mobile wallet applications to the phone. Another challenge is posed by the many competing standards; it is necessary to standardize mobile payment protocols, schemes, and services.

Among other problems, customer apathy seems to be the greatest barrier (Viehland & Leong, 2007). According to Jupiter Research (2008), consumers are uncomfortable with the idea of mobile payment—i.e., "the fear of an unknown medium"—and they are not even willing to try paying with their mobile device. While there are widespread enthusiasm and hope about mobile wallet service, there are also fears of security breaches and identity theft. Mobile wallets provide many functions on a single mobile phone, so that having all your personal and sensitive information stored on a phone poses a great risk if the phone is lost, broken, or stolen.

Despite concerns over security and privacy (Dewan & Chen, 2005), such issues have been addressed in only a few studies,

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and even those few focus on the sheer technical aspects of security and neglect user dimensions such as users' perceived security, trust, and risk. It may be important to investigate how users perceive security and what their privacy concerns over mobile wallets are. This study explores the factors influencing users' perceived security in the mobile wallet. It applies the UTAUT to propose a research model that incorporates self-efficacy, perceived security, trust and subjective norm as enhancing constructs to predict users' motivations for adopting a mobile wallet.

With the integrated theoretical framework, this study conducts an empirical assessment the research model in the mobile payment context. This study seeks to examine the motivations and intentions of mobile wallet users. It offers a set of implications that can help information system (IS) researchers and mobile payment vendors better understand how users develop perceived security and how it contributes to user trust. The structural equation modeling approach, supported by AMOS software, was applied to assess the empirical strength of the relationships in the UTAUT model. The findings should be of interest to both academics and practitioners. From a theoretical perspective, this study provides a model for identifying antecedents of user intention to adopt a mobile wallet in reference to security and privacy. From a practical standpoint, the findings should guide an industry promoting mobile payment in how to build user trust by enhancing usability and appeal, as well as ensuring security. The mobile wallet industry is facing the challenge of how to design mobile payment services that are useful, secure, and controllable (Dahlberg et al., 2008). However, interface designs and related elements are rarely examined as qualities in the context of human computer interaction (HCI). The findings in this study should be useful for mobile payment developers to improve their work. Implications and directions for future study are discussed.

This article is organized as follows: Section 2 provides a literature review on mobile payment and on the theoretical framework used to investigate mobile payment and users. Section 3 proposes the research model and develops the hypotheses tested in this study. Section 4 describes the research method. Section 5 provides the results of empirical tests, which are discussed in Section 6. Section 7 presents conclusions and some implications for practitioners and researchers. Finally, Section 8 describes the limitations of this study and topics for future studies.

2. Literature review

2.1. Mobile wallet trends

The mobile wallet is the newest form of mobile payment that enables users to share content and access services as well as conduct payments and ticketing transactions. Simply put, a mobile wallet is the replacement of a person's wallet with a mobile phone equipped with the functions of a bank card, credit card, house key, company access control ID, subway tickets, membership card, and so on. Jupiter Research (2008) forecasts that the mobile payment market will gain significant traction over 2010–2012. Mobile wallet services are a growing part of the digital economy. Since its inception, the mobile wallet has had exponential business growth with the introduction of its mobile commerce technology and its unique marketing business plan, and through the successful recruitment of a group of an enterprising and strong marketing force (Chen, 2008). With the rapid evolution of mobile technology, and an expanding base of mobile phone users, the mobile wallet has been recognized as having growth potential in the mobile commerce industry (Au & Kauffman, 2007). The industry strives to develop and build solid mobile commerce applications and at the same time provide an environment for secure, convenient, cost-saving and efficient business transactions.

A mobile wallet can support various transactions, including consumer-to-consumer, consumer-to-business, consumer-to-machine (i.e., paying for small-value transactions at a device such as a parking meter), and consumer-to-online. In addition, consumers have greater flexibility for settling transactions at the point of sale with mobile phone payments. The mobile wallet offers faster processing at the point of sale and increased opportunity for impulse buying. Wave-pay-go also reduces the need for cash on hand, which is costly and cumbersome to manage. Furthermore, merchants can more directly engage consumers by sending discount coupons to their mobile handsets. In addition, mobile payments offer carriers the opportunity to establish a stronger relationship with customers by becoming their payment service providers.

As mobile wallets become popular, a rising question is: "Will mobile wallets replace traditional leather wallets?" Or, "How will mobile wallets be positioned in the market?" It may be true that the mobile wallet is an innovative technology that can provide customers with a great convenience, but are consumers ready to embrace this new method of payment? What barriers/incentives might reduce/increase the diffusion of mobile wallets in the consumer market? These still are the elusive questions. This study approaches these questions by analyzing user acceptance behavior.

2.2. The UTAUT model

One of the most used models for studying individual intentions to adopt technology is the technology acceptance model (TAM). Davis (1989) introduced the TAM to explain computer usage behavior. This justifies why TAM is suitable for studies in computer acceptance. Given the rising popularity of mobile commerce and the dynamic user behaviors identified above, the TAM is a suitable framework for this study. There are other widely used and well known frameworks, such as "uses and gratification" or "diffusion of innovation", but the TAM is considered the best fit for this study because other frameworks focus on different levels of analysis (macro, mezzo, or micro) or different topics of emphasis (diffusion mechanisms, etc.). If modified appropriately, the TAM is the most effective tool for a study like this one, which investigates factors relating to usage and adoption, such as social influences and cognitive instrumental dimensions.

The TAM was inspired by the theory of reasoned action, which argues that both the attitude toward an action and subjective norms have an impact on behavioral intention, which in turn affects how people perform an action. The TAM was an early attempt to apply psychological factors to information systems and computer adoption. It assumed that perceived usefulness and perceived ease of use were major influences on an individual's attitude toward using technology and, thus, ultimately, were related to actual use (Davis, 1989). Previous research has demonstrated the validity of the TAM across a wide range of IT. Recently, there is a growing trend for researchers to extend the TAM with various other motivational factors. It has been revised to incorporate additional variables for specific contexts. UTAUT has been proposed as an extension of TAM and a number of studies have shown the validity of the framework in explaining technology acceptance.

This study argues that the TAM may have only a limited ability to explain mobile wallet adoption, for several reasons. Most important, the TAM tends to neglect the social context in which a technology is being adopted. For example, the TAM does not consider social influence in the adoption of new technologies (Malhotra & Galletta, 1999). Second, the TAM assumes that there are no barriers to prevent an individual from using a particular system if he or she has chosen to do so (Mathieson, Peacock, & Chin, 2001). Third, the TAM tends to assume that there is only a single technology available to users. Mobile applications can be heavily influenced by

contextual factors such as social influence, and mobile service adoption may involve complicated factors such as cost. In addition, mobile services are in the midst of fierce competition; it is only one of many payment methods (such as online payment, digital cash, etc.), and customers have many technological options. For these reasons, this study used an integrated model of UTAUT. The mobile wallet in this study is a specific context that calls for additional constructs (such as trust and perceived security) to be incorporated into the UTAUT to better explain variances. Such additional constructs fit nicely into the UTAUT domain.

The UTAUT aims to explain users' intention to use an information system and their subsequent usage behavior. The theory holds that four key constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) are direct determinants of usage intention and behavior (Venkatesh, Morris, Davis, & Davis, 2003). The variables of gender, age, experience, and voluntariness of use are posited to moderate the impact of the four key constructs on usage intention and behavior (Venkatesh et al., 2003). These determinants and moderators will be used to extend the proposed research model. The modified UTAUT model will enable a better explanation of mobile wallet acceptance and usage behavior.

3. Hypotheses

This study proposes an adaptation of the UTAUT that incorporates as variables trust, perceived security, perceived usefulness, and perceived ease of use. Fig. 1 presents the mobile wallet acceptance/use model proposed here. The acceptance of mobile wallets was evaluated using a UTAUT model modified from the one originally proposed by Venkatesh et al. (2003). The research model postulates six constructs (perceived usefulness, perceived ease of use, social influence, self-efficacy, security, trust, and attitude toward using technology) that determine behavioral intent, and two constructs influencing usage behavior (behavioral intent and facilitating conditions). The study examines four moderating variables (gender, age, experience, and voluntariness) that have varying influences on the primary constructs.

The utility of this integrated model stems from the fact that mobile wallets are heavily technology-driven, as well as user-oriented (Dahlberg et al., 2008). This model is well suited to reflect the nature of mobile payment, because it addresses the evolutionary progression of technology and usage dynamics toward a more fluid and agile social existence. In applying this integrated model to a technology-driven environment, the classical TAM variables are posited as key drivers of mobile wallet adoption, and, in consideration of the UTAUT, the model integrates additional key drivers, such as security, risk, and trust. All the key drivers are defined and explained, and their relationship to transaction intentions and the acceptance of the mobile wallet is examined. Placing these variables under the nomological structure of the UTAUT and precisely describing their interrelationships integrates them into a coherent and parsimonious research model.

3.1. Attitude and intention

Since its inception by Venkatesh et al. (2003), the UTAUT has been increasingly studied from the perspective of the field of IS, which is concerned with the determinants of consciously intended behaviors. The model was shown to be 70% accurate at predicting user acceptance of information technology innovations (Venkatesh et al., 2003). By generating a significantly higher percentage of technology innovation success, the UTUAT is deemed a superior metric than the prior metrics.

The UTAUT suggests that a person's performance of a specified behavior is determined by his or her behavioral intention to perform the behavior, and behavioral intention is jointly determined by the person's attitudes and subjective norms (Ajzen & Fishbein, 1980). The best predictor of behavior is intention, which is the cognitive representation of a person's readiness to perform a given behavior, and it is considered to be the immediate antecedent of behavior.

According to the UTAUT, attitude toward a behavior is defined as an individual's positive or negative feeling about performing the target behavior, while subjective norm refers to a person's perception that most people who are important to him or her think he or she should or should not perform the behavior in question. In addition, a person's attitude toward a behavior is determined by his or her salient beliefs and evaluations. Given the wide applicability of the TAM/UTAUT to emerging technologies, it can be

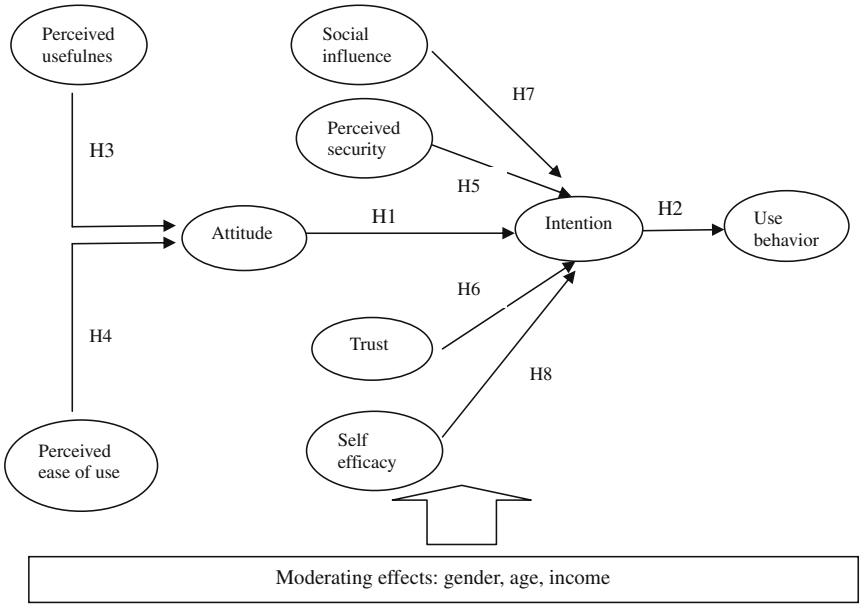

Fig. 1. Proposed research model.

expected that the general causalities found in the UTAUT are applicable to the context of mobile payment. In particular, the relation between attitude and intention has been confirmed (Shin & Kim, 2008).

H1: Attitude toward mobile payment has a positive effect on the intention to use a mobile wallet.

Intention to use technology is a central concept in the TAM (Davis, 1989) and the UTAUT (Venkatesh et al., 2003). Furthermore, intention to use a system can explain a large portion of a user's actual system usage. Intention has been studied in the context of the theory of reasoned action (Fishbein & Ajzen, 1975), which finds an individual's attitude toward a behavior to be a driving factor toward that individual's actual behavior. In this study, behavioral intention is a dependent or endogenous variable, as well as an intermediary variable.

H2: An individual's intention to use a mobile payment will have a positive effect on that individual's usage behavior concerning the mobile wallet.

3.2. Perceived usefulness and perceived ease of use in the TAM

The TAM uses two distinct but interrelated beliefs—perceived usefulness and perceived ease of use—as the basis for predicting end-user acceptance of computer technology. Of the two TAM variables, studies have found perceived usefulness to have the stronger influence (Davis, 1989). There has been a focus on these beliefs in previous studies of consumer acceptance and the adoption of mobile payment (Dewan & Chen, 2005; Teo, Fraunholz, & Unnithan, 2005). The classical definition of *perceived usefulness* by Davis (1989) is that the degree to which a person believes that using a particular system will enhance his or her job performance. The current study highlights the aspect "capable of being used advantageously". This can be a significant conceptual shift from collective productivity to personal productivity. *Perceived ease of use* refers to the degree to which a person believes that using a particular system will be free of effort (Davis, 1989).

H3: Perceived usefulness has a positive effect on attitude toward the mobile wallet.
H4: Perceived ease of use has a positive effect on attitude toward the mobile wallet.

3.3. Perceived security

Given the rising concern over mobile security, this study explores the effect of users' perceived security on intention to use a mobile wallet. *Perceived security* is defined as the degree to which a customer believes that using a particular mobile payment procedure will be secure (Shin, 2008; Yenisey, Ozok, & Salvendy, 2005). Therefore, subjective security can be seen as the mirror image of risk affinity (Dewan & Chen, 2005). Security in interactive spaces does not depend on technical security measures alone. Shin and Kim (2008) show that the feeling of security is largely determined by the users' feeling of control of the interactive system. Cheong, Cheol, and Hwang (2002) examined barriers to mobile payment adoption and reported that the lack of subjective security is the most frequent reason for a refusal to use. Pousttchi (2003) argues that an infringement of subjective security will prevent consumers from using a particular procedure. Dahlberg, Mallat, and Öörni (2003) identified six different types of security risks and stated that these negatively affect the attitude toward using mobile payments. Linck, Pousttchi, and Wiedemann (2006) developed a set of constructs that explain the nature of subjective security.

In line with previous studies, the current study approaches perceived security from a broader perspective that includes not only technical aspects such as confidentiality and authentication (Flavian & Guinaliu, 2006), but also the customer's comprehensive sense of security and well-being. Of mobile commerce, it can be said that customers' perceptions of security can differ from real security levels. Although a scientific assessment of security is based on technological solutions, it is the customers' perceptions of security that influence trust and intention (Linck et al., 2006). A secure transaction may give no indication of the precautions being taken, and a highly insecure transaction can give misleading impressions to customers that they have very good security. It is important to establish measures of perceived security and its relationship to trust in the mobile context. The hypotheses regarding perceived security aim to determine how perceived security influences the intention to use a mobile wallet.

H5: Perceived security has a positive effect on the intention to use a mobile wallet.

3.4. Trust

Reflecting the increasing importance of trust in mobile commerce (Misra & Wickamasinghe, 2004), trust is proposed in this study as an antecedent variable to the intention to use a mobile wallet. It has been defined as the belief that vendors will perform some activity in accordance with customers' expectations (Gefen & Straub, 2004; Pavlou & Gefen, 2004). As trust has been a critical factor in IS (McKnight, Choudhury, & Kacma, 2002), it has been extensively addressed as a research topic from different viewpoints and at different levels of analysis. Mobile customers often feel more uncertain about mobile vendors and the outcomes of mobile transactions (Siau & Shen, 2003). Mobile vendors should, therefore, act to help customers overcome uncertainty by building trust in vendors' web sites and in the Internet as a medium for transactions (Liu, Marchewka, Lu, & Yu, 2005; Nijite & Parsa, 2005).

When it comes to the mobile wallet, trust is even more critical, given the possible risks of being hacked. The growth of mobile payments has a very patchy record. One major concern is that the risk of financial loss acts as an impediment to the adoption of mobile payment. This may be because of widespread knowledge of actual losses, or reports of vulnerabilities, or just because of uninformed concerns and natural risk-aversion. In order to understand the substance of the issue, it is necessary that payment schemes intended for use in mobile contexts be subjected to risk assessment.

H6: Trust in virtual malls positively affects the customer's intention to use a mobile wallet.

3.5. Self-efficacy

Self-efficacy theory states that behavior is cognitively mediated by the strength of a person's self-efficacy beliefs (Bandura, 1997). *Self-efficacy* is defined in this study as an individual's assessment of his or her ability to perform desirable behaviors in specific situations. Perceptions of self-efficacy are not reflective of a global personality trait; rather, they vary across different behavioral domains (e.g., physical self-efficacy, productivity self-efficacy, play self-efficacy, and so forth). It is suggested that the greater a user's self-efficacy, the greater the user's intention to use mobile wallet. Based on

the assumptions in the model, this study proposes the following hypothesis:

H7: Self-efficacy is positively related to the customers' intention to use a mobile wallet.

3.6. Social influence

As noted by several IS researchers (Brown & Venkatesh, 2005; Davis, 1989; Hsu & Lu, 2007), the TAM is incomplete in one key respect: It does not account for social influence in the adoption and utilization of new technologies. Nysveen, Pedersen, Thorbjornsen, and Berthon (2005) define *social influence* as "the person's perception that most people who are important to him think he should or should not perform the behavior in question" (p. 332). The importance of normative pressure on intention to use mobile services is revealed in studies that are based on the information systems perspective (Teo & Pok, 2003). As Nysveen et al. (2005) show, people use mobile services in a public social context in which they observe others' activities and in which they must adapt to others' interactions. In addition, previous studies consistently show that social influence can determine individuals' behaviors (Venkatesh & Morris, 2000; Wu, Tao, & Yang, 2007). Specifically, Shin (2007) found that social influence (subjective norm) is a determinant in the unique feature of mobile Internet via mobile devices.

Based on previous studies on social influence, the research model here hypothesizes a positive relationship between subjective norm and intention. This is confirmed by recent empirical studies (Cheong et al., 2002; Shin, 2007), by a review of the literature (Dahlberg et al., 2008), and by theoretical models such as the theory of reasoned action and the theory of planned behavior (Lucas & Spitler, 2000; Venkatesh & Morris, 2000).

H8: Social influence positively influences customers' intentions to use a mobile wallet.

3.7. Moderator effects

Moderators (or *control variables*) are variables that represent constructs proposed to magnify, attenuate, cancel, or reverse the association between two other variables (Baron & Kenny, 1986). Statistical moderation can take many forms, but the defining feature of a moderate effect is that the association between the independent variable and the dependent variable differs in strength or form at different values of the moderator. For example, attitudinal similarity might be even more predictive of attraction for women than men (i.e., gender moderates the similarity-attraction effect). Despite their potential value, the use of moderators is currently under-represented, especially, in technology adoption research (Shin, 2007). However, the use of moderators may potentially increase the predictive validity of a model under investigation, and explain inconsistent findings in various disciplines (Shin, 2008). Sun and Zhang (2006) argue that the low explanatory power and factor inconsistencies of TAMs may be explained by the exclusion of important moderating variables that reflect individual differences such as age and gender. Empirical studies continue to show that age, income, and gender play a crucial role in affecting the strength and direction of various relationships in many models (Ha, Yoon, & Choi, 2007). According to the literature related to personal determinants of IT behavior, these three demographic factors are supposed to have a moderating impact on linkages in the TAM. Three demographic factors were chosen, in order to see if there were differences in their explanatory power. Each of these factors has been found to be relevant in the context of customer satisfaction and/or loyalty in previous studies.

In the TAM research, age has been an important personal characteristic within the category of demographic variables. In practical terms, the identification of age groups within a population allows for market segmentation. TAM research has consistently found that age moderates a variety of construct relations. For example, Venkatesh et al. (2003) found that age moderates technology adoption-related relationships. In addition, Koufaris (2002) found that age moderates online shopping-related relationships. Such studies demonstrate that different age groups perceive and behave differently; therefore, age may moderate some of the variables in mobile wallet adoption.

Income is another demographic characteristic that has attracted considerable research attention. One's income is presumed to have a strong impact on decisions. In a general sense, it is assumed that people with higher incomes have achieved a higher level of education. Income is one of the major determinants of product and service demand, and is used for forming market segments with varying purchasing powers. Previous findings (Allard, Banin, & Chebat, 2009; Serenko, Turel, & Yol, 2006) suggest that the identification of the role of income as a moderator of technology adoption is important. Hence, income is suggested as another demographic characteristic that might have a moderating effect.

Gender is considered in this study as an important personal characteristic. The impact of gender on adoption behavior has attracted some research interest (e.g., Ha et al., 2007; Sun & Zhang, 2006). Female's IT usage behavior is found to he strongly influenced by their evaluation of personal interaction processes (Gefen & Straub, 1997). Compared to male, female are more involved in purchasing activities and pay more attention to the consulting services of sales personnel. In the context of technology acceptance, gender and its interactions with other adoption predictors have been shown to affect adoption behaviors (Venkatesh et al., 2003). These arguments lead to the suggestion that gender might moderate the linkages between attitude and intention.

Based on the literature review, the proposed model is delineated in Fig. 1.

4. Study design

The study design largely follows the mobile payment survey design method used by Dahlberg and Öörni (2007). The survey method consisted of four phases. First, individual in-depth interviews were conducted with possible customers; ten undergraduate students were asked to explain their opinions of the mobile wallet. Second, with the help of IS majors at a university, six focus groups were organized, and group interviews were conducted, in which groups of 4–6 individuals discussed how they currently use mobile payment and what factors would influence their use of mobile payment in the future. The goal of the individual interviews and focus group sessions was to test and validate the research model, to identify items missing from the UTAUT, and to gain a preliminary understanding of the factors that have an impact on payment behaviors.

Third, based on the focus group sessions, the final survey questionnaire was developed through several comment rounds of an expert panel consisting of professors and researchers, as well as mobile payment systems experts. Prior to its use, the questionnaire was tested by administering a pilot survey among possible users, who provided a comprehensive review of individual responses to the pretest survey. The pilot test analysis consists of a detailed comparison of the data for each of the pretest survey participants with other responses. The wording of items was reviewed and modified, based on the pilot test outcomes, by three marketing professors knowledgeable in quantitative research.

A pilot test was undertaken to examine test–retest reliability and construct reliability before conducting the fieldwork. Twenty undergraduate who had had experience with mobile commerce and mobile payment participated, with tests given at a three-week interval. The participant group was familiar with mobile applications, and, prior to answering the questionnaire, they were strictly instructed to ask the experimenter any questions about questionnaire items that they didn't understand. With these precautions, the possibility of participants' filling out some questions without exactly understanding the content of those questions was eliminated. Finally, to reduce questions' possible ambiguity in syntax and semantics, a final pilot test, involving 22 respondents self-selected from the mobile community, was performed.

The finished survey was administered online. From August to December 2008, a Web-based survey questionnaire was posted on discussion forums devoted to mobile payment, mobile commerce, and mobile games, and on the forums of several professional associations, and the members of each community were cordially invited to participate. A cover letter was attached to explain its purpose and to ensure confidentiality. By the time the survey ended, 638 visitors had browsed it, and 326 questionnaires were submitted. Of the submitted questionnaires, 30 were excluded because of incomplete answers, leaving 296 usable responses. The web site where the questionnaire was posted had a tracking function showing how many users had visited the site: 2289 over the six-month period. A total of 2520 users visited the site and presumably saw the invitation, but declined to participate. The response rate was 30.3%, a fairly desirable rate in survey methodology (Shin, 2007).

As the use of the mobile wallet is still an emerging phenomenon, it was important to ensure that the participants had an appropriate level of exposure to, and experience of, mobile payment (Chou, Lee, & Chung, 2004). Hence, a screening questionnaire was used to determine whether or not users had had substantial experiences with this mode of exchange. It asked respondents about their usage patterns, their frequency of use for various mobile services, including mobile payment, and their average amount of use. Respondents with substantial experience were invited to the survey. In order to increase validity and generalizability, subjects were recruited from various mobile providers, such as Verizon, AT&T, Sprint, Cingular, and Nextel.

Table 1 presents the sample demographics. The final sample is rather unbalanced in terms of age, education, and experience. This may have resulted from pre-screening procedure that selected users of substantial experiences with mobile usage. Given the nature of mobile payment, however, this unbalance is understandable because a large number of mobile users are young and college-educated and able to afford a computer or interested in having one. Thus, the collected sample in this study reflects the general population of mobile services. For the analysis of statistics, AMOS, a maximum likelihood-based SEM software, was used. There are several software packages exploring nonlinearities and interactions in cause-effect-models, such as LISREL, EQS, SEPATH, and PLS. Among them, AMOS for Windows (version 16) was selected for the structural equation model because it seems to provide reasonable, replicable results. AMOS is a covariance-based approach, in which the covariance structure, derived from the observed data, is used to simultaneously fit the measurement and structural equations specified in the model. SPSS's version of AMOS is a competitive package that implements a general approach to data analysis known variously as *structural modeling*, *analysis of covariance structures*, or *causal modeling*. In addition, AMOS provides a rich modeling framework for theory-building and model testing. Given the analytical capability of AMOS, it is the best choice for producing valid results (Arbuckle, 2005).

Table 1
Characteristics of respondents (total = 296).

Age	Number	%	Education	Number	%
Under 20	70	23.4	High school or −	41	14.0
21–30	167	56.0	College	183	61.4
31–40	49	16.6	Graduate or +	74	25.0
41–50	9	3.2	Gender	Number	%
Over 51	1	0.3	Female	131	44.2
User experience	Number	%	Male	172	55.8
1–3 months	25	8.6	1–2 years	126	42.5
3–6 months	33	11.3	2–3 years	37	12.6
6 months–1 years	46	15.4	3 years +	27	9.0

4.1. Measurement development

The participants indicated their agreement with a set of statements, using a 7-point Likert-type scale (ranging from "strongly disagree" to "strongly agree") drawn from previously validated instruments. The measures of perceived usefulness, perceived ease of use, behavioral intention and attitude were adapted from previous studies relating to the TAM model, mainly from Davis (1989). To address the elements of perceived security and trust, this study used items by Yenisey et al. (2005) and Salisbury, Pearson, Pearson, and Miller (2001). The measure used to assess self-efficacy was taken from Schwarzer (1994). Subjective norm was measured with items from Song and Kim (2006). The final scales used in this study consisted of 27 items, three items per each factor.

4.2. Data analysis

4.2.1. Measurement instrument

The reliability and validity of the measurement instrument were evaluated with SPSS15, using reliability and convergent validity criteria. The reliability of the survey instrument was established by calculating Cronbach's alpha to measure internal consistency. Each construct was tested for reliability and content validity, using Cronbach's alpha (Cronbach, 1971). Most of the scores were above the acceptable level, that is, above 0.70. The variables in this study, derived from the existing literature, exhibited strong content validity.

The convergent and discriminant validity of the model were examined using the procedure suggested by Fornell and Larcker (1981), who recommend measuring the reliability of each measure and each construct, and the average variance was extracted (AVE) for each construct. The reliability of each item was examined using a principle components factor analysis. Table 3 shows the results of this analysis, with varimax rotation on the original 26 items (four items were eliminated due to low loading). According to Hair, Anderson, Tatham, and Black (1995), a measurement item loads highly if its loading coefficient is above 0.6. This analysis showed that most items had factor loadings higher than 0.7, which Fornell and Larcker (1981) consider to be very significant. Each item loaded significantly on its underlying construct ($p < .001$ in all cases). Therefore, all constructs in the model had adequate reliability and convergent validity. To examine discriminant validity, this study compared the shared variance among constructs with the AVE from the individual constructs. The shared variance between constructs was lower than the AVE from the individual constructs, confirming discriminant validity (Table 2). In short, the measurement model demonstrated adequate reliability, convergent validity, and discriminant validity.

The wording used in the questionnaire items was similar, so that the responses could be highly inter-correlated. Possible multi-collinearity problems can be effectively removed by a principal component analysis. In addition, a correlation analysis of Pearson's R (a correlation coefficient) shows an acceptable level of correlation among variables.

Table 2
Discriminant validity.

Construct	1	2	3	4	5	6	7	8
Perceived security	0.71							
Perceived usefulness	0.25	0.19						
Perceived ease of use	0.23	0.18	0.61					
Social influence	0.64	0.22	0.57	0.62				
Self-efficacy	0.17	0.23	0.45	0.71	0.32			
Trust	0.06	0.75	0.14	0.29	0.59	0.32		
Intention	0.35	0.14	0.10	0.29	0.28	0.62	0.43	
Attitude	0.41	0.15	0.18	0.14	0.24	0.34	0.61	0.54

Notes: Diagonals represent the average variance extracted. Other entries represent the shared variance.

Table 3
Principal component analysis with varimax rotation.

Component	1	2	3	4	5	6	7
PS1	**0.773**	0.134	0.189	0.299	0.123	0.152	0.239
PS2	**0.747**	0.292	0.232	0.045	0.211	0.134	0.135
PS3	**0.700**	0.219	0.264	0.370	0.233	0.023	0.272
PEoU1	0.163	0.287	0.243	**0.810**	0.150	0.151	0.363
PEoU2	0.262	0.194	0.301	**0.751**	0.180	0.121	0.116
PEoU3	0.227	0.224	0.273	**0.762**	0.190	0.338	0.258
PU1	0.199	0.329	0.119	0.229	0.253	**0.815**	0.225
PU2	0.099	0.263	0.109	0.444	0.629	**0.863**	0.256
PU3	0.279	0.192	0.171	0.383	0.240	**0.737**	0.327
SI1	0.292	0.231	0.240	0.114	**0.796**	0.198	0.084
SI2	0.199	0.192	0.291	0.196	**0.790**	0.166	0.215
SI3	0.093	0.201	0.181	0.047	**0.729**	0.250	0.187
I1	0.228	0.101	**0.715**	0.476	0.182	0.206	0.276
I2	0.193	0.234	**0.723**	0.326	0.185	0.199	0.326
I3	0.048	0.305	**0.812**	0.316	0.240	0.155	0.116
A1	0.277	**0.741**	0.285	0.088	0.180	0.190	0.018
A2	0.277	**0.758**	0.228	0.273	0.182	0.199	0.193
A3	0.120	**0.811**	0.204	0.382	0.249	0.200	0.292
TR1	0.293	0.178	0.242	0.261	0.130	0.167	**0.799**
TR2	0.224	0.283	0.264	0.139	0.212	0.157	**0.802**
TR3	0.293	0.218	0.139	0.392	0.251	0.511	**0.807**
α-Value	0.8883	0.8961	0.8477	0.8511	0.9101	0.8877	0.8672
AVE	0.74	0.69	0.73	0.77	0.72	0.71	0.78

Note: Numbers in bold shows loading coefficients for items in each construct.

4.2.2. Structural model

Structural equation modeling was used to analyze the data. Structural modeling evaluates whether the data fit a theoretical model. Table 4 shows the estimates from the structural modeling. The overall fit of the model is satisfactory, with all of the relevant goodness of fit indices greater than 0.90. The GFI is 0.95, the AGFI 0.89 and the TLI 0.91. Similarly, there is no evidence of misfit, with the RMSEA showing a very satisfactory level of 0.067, which compares favorably to the benchmarks by Joreskog and Sorbom (1996), who suggest that values of 0.06 or more reflect close fit. The standardized RMR was also very good, at 0.027, well below the threshold for a good overall fit. Another positive test statistic was the normed chi-square value (a chi-square divided by degrees of freedom) of 1.98, a value that is appropriately below the benchmark of three, to indicate good overall model performance. Given a satisfactory measurement of the model's fit to the data, the path coefficients of the structural model were assessed.

4.2.3. Possible moderating effects and extended model

Given the complex relations among the factors in the model, what should be considered is their moderating effect on other variables. It can be reasonably inferred that there are unexpected moderating relationships in the model. In addition, given the importance of trust in m-commerce as numerous studies have shown, trust may exert moderating effects on the relationships. This study adopts the product indicator approach proposed by Chin, Marcolin, and Newsted (2003) to measure the moderating effects model.

Table 4
Fit indices for the measurement model and structural model.

Fit statistics	Structural model	Recommended value
Chi-square/df	268.352, df = 269; p = .000	—
Normed chi-square	1.98	<5 (Bagozzi & Yi, 1988)
AVE	—	>0.50 (Fornell & Larcker, 1981)
p-Value	0.000	<0.05 (Bentler, 1990)
Goodness of Fit Index (GFI)	0.95	>0.9 (Bagozzi & Yi, 1988)
Adjusted Goodness of Fit Index (AGFI)	0.89	>0.8 (Etezadi-Amoli & Farhoomand, 1996)
RMSEA (Root Mean Square Error Approximation)	0.067	>0.06 (Joreskog & Sorbom, 1996) >0.05 (Byrne, 2001)
Standardized RMR	0.027	The smaller the RMR, the better the fit (Byrne, 2001)
TLI (Tucker-Lewis Index)	0.91	Approaches 1(Byrne, 2001)

This study extends the proposed research model to include the effects of two interactions (between trust and social influence, and between self-efficacy and perceived ease of use) and two direct effects (of trust on attitude and of trust on self-efficacy). Trust exerted direct effects, rather than moderating effects, on attitude and self-efficacy, which in turn significantly affected intention. For the extended model, the direct and moderating effects are shown in Fig. 3.

5. Results

5.1. Structural paths and hypotheses tests

To test structural relationships, the hypothesized causal paths were estimated. Six hypotheses were supported and two were rejected. The results are reported and depicted in Table 5 and in Fig. 2. The overall fit of the model is acceptable, since the goodness-of-fix statistics are satisfactory and acceptable. The results generally support the proposed model, illustrating the new roles of perceived security and trust in mobile wallet services. The specified relationship between perceived usefulness and attitude was supported by the data, as indicated by a significant critical ratio (CR = 2.113). The CR is a t-value obtained by dividing the estimate of the covariance by its standard error. According to Arbuckle (2005), CR values larger than 1.96 and 2.32 are statistically significant at 0.05 and 0.01, respectively. Ease of use of mobile wallet services may be conducive to reaching a higher level of positive attitude. Perceived security was the most important determinant

Table 5
Summary of hypothesis tests.

Hypothesis	Estimate	S.E.	C.R.	Support
H1: Attitude → Intention	0.406*	0.014	2.122*	Yes
H2: Intention → Behavior	0.399*	0.103	2.152*	Yes
H3: PU → Attitude	0.422*	0.016	2.113*	Yes
H4: PoEU → Attitude	0.301*	0.091	2.012*	Yes
H5: PS → Intention	0.621**	0.459	4.013**	Yes
H6: Trust → Intention	0.530**	0.218	3.254**	Yes
H7: SI → Intention	0.072	0.154	0.392	No
H8: SE → Intention	0.034	0.149	0.042	No

S.E. is an estimate of the standard error of the covariance.
C.R. is the critical ratio obtained by dividing the covariance estimate by its standard error.
* Values are critical ratios exceeding 1.96, at the 0.05 level of significance.
** Values are critical ratios exceeding 2.32, at the 0.01 level of significance.

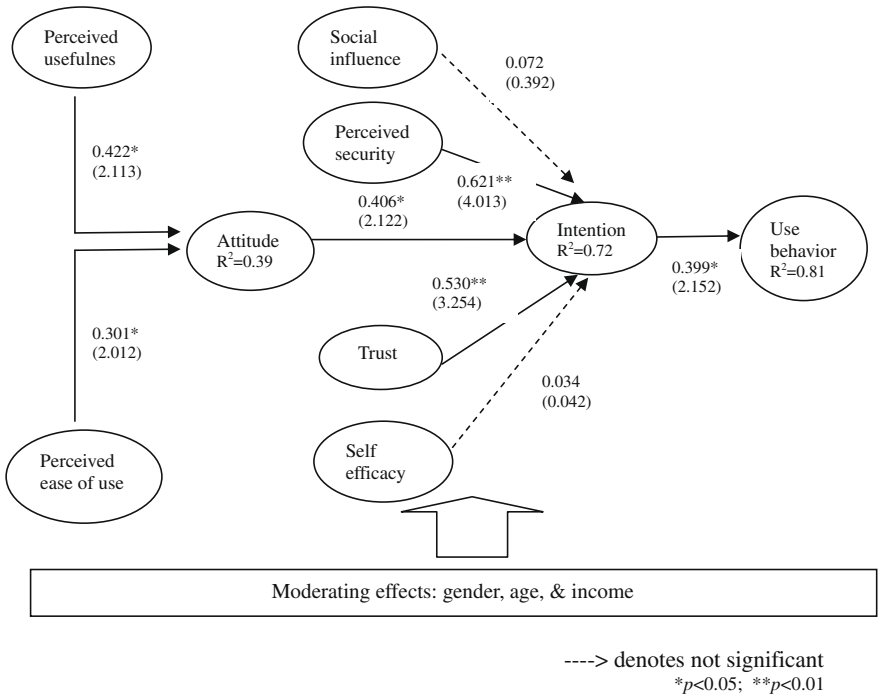

Fig. 2. Result of the research model.

of user intention for mobile wallet services (CR = 4.013). This reflects the significant effect of trust on user intention (CR = 3.254). On the other hand, the effects of social influence (CR = 0.391) and self-efficacy (CR = 0.042) on use intention were not supported by the results. There is a significant positive relationship between attitude and intention to use, and strong support for a positive relationship between intention to use and use behavior. The results imply that perceived usefulness/ease of use may influence attitude, which, in term, affects customers' use intention. The enhanced use intention, which then again is enhanced by perceived security and trust, affects actual use behavior.

Fig. 2 displays all the structural relationships among the constructs studied. The figure indicates that the variance in mobile wallet usage explained by the model is 71%, which is fairly high, given that numerous factors may affect acceptance of, and intention to use, the service. The results show that the variance in individual intentions toward accepting the mobile wallet can be explained by the large proportion of perceived security and trust, along with a relatively small proportion of social influence and self-efficacy. Variance in individual attitude toward the mobile wallet was explained 39% by perceived usefulness and ease of use.

5.2. Results of moderator effects

In order to investigate demographic moderator effects on mobile wallet use/adoption, moderation analysis was done using the split sample approach (Ha et al., 2007; Serenko et al., 2006). This approach uses a pre-established level of a moderator, which emerges naturally from the study and cannot be modified by researchers. For example, a person's gender, recorded as male or female, naturally forms two moderator levels.

To identify a moderation level for age, the dataset was divided to form two sets, each representing individuals who belong to a particular generation. An analysis of age distribution demonstrates that two major age groups emerged: Junior and senior groups. Representatives of these generations may be fundamentally different in terms of various characteristics, perceptions, and behaviors. Serenko et al. (2006) used 40 years of age at the day of the survey as a cut-off point.

To specify a moderation level for income, they used the US median household income reported by the US Census Bureau. This study follows Serenko's criteria on age (40 years old) and income (the median annual household income in 2007 was $50,233 according to the Census Bureau).

The moderating effects of user variables were tested by comparing, between the two groups, the path coefficients produced for each moderator. Path coefficients were calculated using *t*-values suggested by Chow (1960). Table 6 shows the results of the path coefficient comparisons, which reveal a number of significantly different structural relationships. The path coefficient from perceived security/trust to intention for the high-income group was significantly larger than that for the low-income group. However, the other paths were not significantly affected by income level. The influence of acceptance factors differed substantially according to the subject's age. Perceived ease of use was a more important factor among older than younger people in influencing attitude and intention. However, in the paths from social influence to intention and from self-efficacy to intention, the coefficients from younger people were significantly stronger than that those from older people. Gender did not affect any of the factors for adoption or use of the mobile wallet.

5.3. An extended research model

It is notable that self-efficacy and social influence were found to have no significant effect on any of the paths. This is an interesting characteristic of mobile wallet services, since most other technology adoption models have credited the influence of the self-efficacy/social influence factor on behavioral intention (Agarwal & Karahanna, 2000; Shin & Kim, 2008; Venkatesh et al., 2003; Compeau, Higgins, & Huff, 1999). While this reveals an important but uncommon insight for the mobile wallet, this study explores other possibilities. Given the minimal contribution of self-efficacy and social influence to the explanation of behavioral attitude and intention, what should be considered is their moderating effect

Table 6
The results of moderate effects.

Path	Gender		t	Age		t	Income		t
	Male	Female		Senior	Junior		High	Low	
H1: Attitude → Intention	0.401*	0.398	1.482	0.421	0.592	2.011*	0.424	0.134	2.594*
H2: Intention → Behavior	0.369*	0.401	0.391	0.193	0.439	3.221*	0.501	0.131	2.921*
H3: PU → Attitude	0.422*	0.382	0.291	0.421	0.434	0.453	0.499	0.031	3.422*
H4: PoEU → Attitude	0.301*	0.321	0.4011	0.101	0.322	0.189*	0.311	0.299	0.531
H5: PS → Intention	0.621**	0.403	0.312	0.139	0.531	2.322*	0.410	0.124	0.412**
H6: Trust → Intention	0.530**	0.403	0.324	0.112	0.699	4.422**	0.611	0.139	3.991*
H7: SI → Intention	0.072	0.131	0.144	0.192	0.429	0.323*	0.291	0.432	1.644
H8: SE → Intention	0.034	0.013	0.153	0.123	0.331	0.203*	0.153	0.014	0.431

* $p < .05$.
** $p < .01$.

on other variables. It can be reasonably inferred that there are unexpected moderating relationships in the model: Between perceived security and trust, between perceived security and intention by subjective norm, between perceived ease of use and attitude, and between intention and usage by self-efficacy. In addition, given the importance of trust in m-commerce, trust may exert moderating effects on the relationships between attitude and intention, and between perceived security and intention. These roles of trust were tested by Fang, Shao, and Lan (2009).

As indicated in Section 4, this study adopts the product indicator approach proposed by Chin et al. (2003) to measure the moderating effects model. In order to see the moderating effects of self-efficacy, the effect of self-efficacy on intention was removed. As a result, the degree of the effect of perceived ease of use on attitude was noticeably lowered. A similar result was found when social influence was removed from the model; two path effect sizes were noticeably lowered—the path of attitude to intention, and the path of intention to usage.

It can be said that the effects of attitude on intention and the level of trust are influenced by word-of-mouth from users' peers or other people. Users tend to voluntarily spread word of their experiences to peers, who may be reassured by their mobile buddies regarding possible benefits and risks with mobile wallets. In the same manner, users' perceived ease of use can be reinforced both consciously and unconsciously through user self-efficacy. Although previous studies show the moderating effect of demographics and individual experience, not many studies have investigated the moderating effect of complicated paths among the observed factors.

However, moderation by trust is insignificant. Consequently, trust seldom moderates the relationship between attitude and intention and the relationship between perceived security and intention. Trust is posited to exert direct effects on attitude and self-efficacy, which demonstrates that the direct effects method is superior to the moderating effects model.

Accordingly, this study extends the proposed research model to include the effects of two interactions (between trust and social influence, and between self-efficacy and perceived ease of use) and two direct effects (of trust on attitude and of trust on self-efficacy). Trust exerted direct effects, rather than moderating effects, on attitude and self-efficacy, which in turn significantly affected intention. The result was consistent with previous research findings (Fang et al., 2009). For the extended model, the direct and moderating effects are shown in Fig. 3.

The fit indices of the extended research model are reported in Table 7. All indices are well above or below the cut-off points. The current study found that the extended model has the same major links as those identified by the proposed research model.

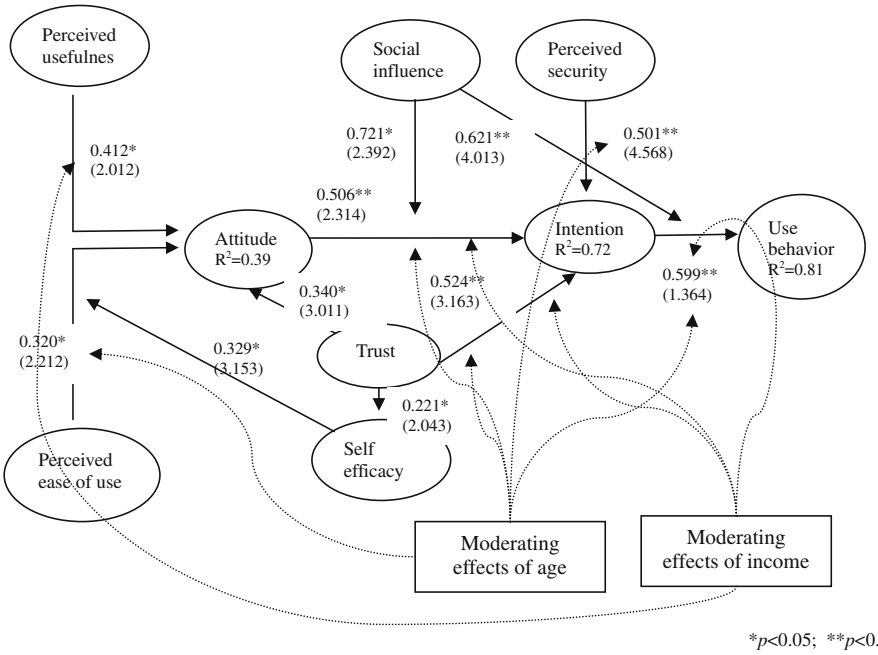

Fig. 3. Extended model.

Table 7
Fit indices for the extended model.

Fit statistics	Structural model
Normed chi-Square	1.96
p-Value	0.000
AGFI	0.96
RMSEA	0.071
CFI	0.96
NFI	0.89
IFI	0.98

The normed chi-square for the extended model was 1.96. The AGFI, CFI, and IFI values were 0.96, 0.96, and 0.98, respectively. The NFI and NNFI values were 0.89 and 0.95, with the RMSEA at 0.071. These results suggest that the measurement model adequately fits the data. The notable aspect of the extended model may be that the significance of social influence and attitude on intention is greatly increased. It appears that the impact of trust on intention to play is enhanced through social influence, and in the same manner, the impact of perceived ease of use on attitude is increased by the effect of self-efficacy. This finding fits nicely with the significance of the moderating roles of social influence and self-efficacy. These moderating roles can help to explain the interesting results regarding the influence of social influence and self-efficacy on attitude and behavioral intention in IS research. The results indicate that mobile users seriously care about peer players' opinions when they perceive risks associated with mobile payment.

5.4. Bootstrapping

A bootstrapping re-sampling procedure is a nonparametric approach for estimating the precision of paths and assessing whether or not moderating effects are significant (Ravichandran & Rai, 2000). Bootstrapping is certainly an alternative here because the responses from the sample might not fit the norm. When it comes to the mobile wallet, the US market still has not found the right kind of mobile payment model (Dahlberg et al., 2008). In this study, bootstrapping involving 200 re-samples was performed to derive *t*-statistics for the structural paths, to obtain better statistical significance for the extended research model. The path significance and *t*-statistics are shown in Fig. 3. This number of re-samples was sufficient for obtaining adequate parameter estimates (Chin, 2001). Standard errors for calculating *t*-values are shown in parentheses next to the path coefficients. The structural model results from the extended model provided reasonable support for our theoretical model. The analysis explained a moderate-to-large amount of variance in the endogenous constructs.

6. Discussion

The purpose of the current study was to empirically extend the UTAUT in order to explain the development of individuals' behavioral intentions toward, and use of, mobile wallets. For this goal, new constructs adapted from other studies were employed to reflect the features of the mobile wallet. This study used an integrated model of UTAUT. The results promise to add to our understanding of users' attitudes and intentions in mobile payment and to clarify implications for the development of effective mobile wallet applications. The results of the measurement and structural model test lend support to the proposed research model. Overall, the results show that the models demonstrate good predictive powers and explain behavioral intentions toward the mobile wallet.

As expected, and consistent with prior research, the results show that perceived security and trust are the two main predictors of intention. Previous studies and industry reports have shown that security concerns are the most important factor in mobile payment. The present study confirms the importance of security and trust, and further shows that security and trust can be enhanced by social influence. These findings together raise a need to highlight the customer's subjective viewpoint. As Linck et al. (2006) argue, the perception of mobile payment security by the customer is one major factor for the market breakthrough of the system. Although the issue of security has emerged as a major inhibitor of mobile payment acceptance, the research on this issue is quite rare to date, especially from the viewpoint of customers. The current study seeks to approach the issue from an empirical perspective, in order to come to a better understanding of the concept of mobile security. It sheds light on the basic distinction between the dimensions of objective and subjective security. In this study, the users' subjective norm, based on social influence, shows a much stronger impact on intention than previous studies on mobile use have indicated (Dahlberg et al., 2003; Dahlberg & Öörni, 2007). This suggests that mobile wallet users are more influenced by their peers in their decisions to use than other mobile application users. Given the immature stage of the mobile wallet, customers may want a subjective norm, which increases their intention to adopt and use. Judged from the high level of its effect on intention, social influence apparently plays a role in moderating perceived security, and, together, the two co-influence intention, acting as a direct reinforcement. In sum, the extended model reveals the vital role of social influence in the adoption process.

Based on findings of the importance of customers' perceived security, vendors should implement security tools like the Mobile Transaction Assurance Seal for mobile commerce. Mobile trust mechanisms, such as payment credentials, trust negotiation systems, and a trusted third party system are necessary to increase users' perceived security. All forms of mobile transactions will involve the electronic exchange of smart card and financial information. Security for this information exchange is critical. In particular, in mobile transactions enabled and facilitated by mobile agent technologies, shared trust among customers clearly has the potential to catalyze a powerful means of communication and transactions. Once security concerns are resolved, transactions via mobile wallets will become as secure as those in traditional physical banks.

The findings indirectly support previous research on trust, because users reported that the reliability of system and user confidence were important for their intention to use a mobile wallet. Previous studies, however, did not address the relation between intrinsic motivation and trust, or the possible underlying effects of subjective norm and perceived security on other motivational variables. Filling a gap in these studies, the findings in the current study find a significant role for perceived security and its underlying linkage to other variables—namely, how it is related to usage, subjective norm, and, possibly, self-efficacy. This finding constitutes a theoretical improvement for the UTAUT. As antecedent variables, the roles of trust and security are important, because one of the limitations of the current literature is that it does not help us to explain acceptance in ways that guide development, beyond suggesting that system characteristics have an impact on perceptions of ease of use and usefulness. Therefore, it is essential to understand the antecedents of the key acceptance variables in order to be able to explain individuals' acceptance and use.

7. Implications for theory and practice

The results of this study contain several implications for researchers as well as for the mobile wallet industry. The empirical findings demonstrate that employing perceived security and trust would be a worthwhile extension of the UTAUT in the mobile context, as both were found to be influential in predicting attitude and

behavioral intention to use a mobile wallet. A primary contribution of this study is that it highlights the moderating roles of demographics, self-efficacy, and social influence in the context of a new virtual environment. Although plentiful studies are presented in the mobile literature, few have used integrated models of trust and security, or methods to assess these factors in emerging mobile literature. Prior research on mobile adoption examined the impact of trust, flow and subjective norm on playing intentions for mobile games, assuming that trust in mobile payment and the subjective norm of mobile payment would have an effect on intention to use the service (i.e., Chen, 2008; Cheong et al., 2002; Dahlberg et al., 2003). However, previous studies have neglected to investigate the relationship of security to other factors of subjective norm. The present study indicates that perceived security, as a variation of trust and subjective norm, exerts important influences on users' intentions, as well as on their usage behavior. Behavioral intention can be viewed as an individual's underlying attitude, which ultimately determines behavioral intentions via attitude (Ajzen, 1991). Thus, this study contributes to the literature on the UTAUT research by confirming that perceived security, as a salient belief, can influence behavioral intention and loyalty through attitude.

The recognition of the moderating role of demographics among the factors is particularly notable in this study. The current research suggests that social influence plays a moderating role in establishing a positive attitude, by affecting the relation between perceived security and attitude. Social influence also plays a facilitating role toward intention, by affecting the path from perceived security to intention. The links identified here can be a first step toward a synthesized and integrated model of mobile wallet acceptance. However, future studies should further investigate the complex interrelationships among perceived security, perceived usefulness, trust, and social influence to clarify possible intricate relations. In particular, based on the fact that the moderating effects of demographics were found to be significant, future studies may delve further into the complicated effects of diverse demographics beyond gender and age.

Practical implications for industry can be drawn from these findings, in terms of strategies and new models for mobile wallet services. The finding that security impacts behavioral intention through attitude indicates that vendors should establish user trust in mobile wallet security by ensuring that their services are conducted in accordance with users' expectations—namely, that their services are reliable, and that promises and commitments are kept.

In conclusion, considering the ever-changing nature of the mobile environment, this study offers help in understanding behaviors associated with the mobile wallet, and in understanding the implications for developing effective mobile services. As users accept the mobile wallet as a new means of commerce, and as firms provide enabling platforms for users, the mobile wallet might become a killer application for the next generation of mobile platform applications. However, in order to become popular, mobile wallets have several challenges to overcome, and user acceptance is probably the most important one. Service developers need a better understanding of individual perceptions concerning the level of security and the influence of social influence on intention to use and return to use. This study provides a basis for an evaluative framework to determine the adoption potential of new mobile payment services. The unified framework in this study can be a good tool for understanding market potential by analyzing users' demands and prototyping market profiles.

8. Limitations and future studies

Several limitations narrow the scope of the above conclusions. First, the findings reflect only limited aspects of user experiences with mobile wallets. Because mobile payments are not a mainstream phenomenon yet in the US (Chen, 2008), this research is exploratory. These circumstances lead to a limited generalizability. Since this study focused on mobile wallet services, it is hard to generalize the findings to other mobile contexts. Given that the population of mobile users currently runs over several million, the sample size of 296 may be disproportionate to the whole population of mobile users. In addition, the research model is only valid for the US mobile market due to the restrictions of data collection.

With all these limitations, the lingering question is: To what extent do the findings of this study reflect the actual phenomena of mobile wallets? Future studies will be able to sample a larger and more typical number of users. This may be achieved using stratified sampling or a quota sampling method to insure a certain distribution of demographic variables. A generalized application of the extended model would require a global data collection process for a more thorough validation. In addition, since intrinsic motivation, perceived security and social norm are additional antecedents of attitude and intention, it is not possible to generalize the findings to other mobile applications. For example, since perceived security is a subjective matter, all mobile users would express concerns regarding security, but there are differing security threats and responses to those threats. In all, this study took a first step at exploring user experience with mobile payment and found a number of metrics to be reliable and nomologically valid. Despite its several limitations, one important contribution may be the exploring and testing of metrics for user behaviors in regard to the mobile wallet. In addition to the fact that all the scales used in the study showed high reliability, those of flow, subjective norm, and perceived security also demonstrated high nomological validity. Therefore, future research can use these metrics with some careful assurance. Testing them against other factors will advance the understanding of users' mobile payment behavior in a new era of mobile commerce.

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