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Factors Influencing Behavioural Intention to Use the Mobile Wallet in Singapore

A. Seetharaman[1]
S P Jain School of Global Management, Singapore

Karippur Nanda Kumar
S P Jain School of Global Management, Singapore

S. Palaniappan
S P Jain School of Global Management, Singapore

Golo Weber
S P Jain School of Global Management, Singapore

Abstract

The convergence of telecommunications, payment systems and mobile devices created new possibilities and the Mobile Wallet is one such possibility. This research attempts to understand the key factors that influence the acceptance of mobile wallet in Singapore. The Technology Acceptance Model (TAM) was expanded to include innovativeness, critical mass, transaction security, trust, flexibility, cost of transaction, consumer privacy and anonymity, transaction speed and availability of alternatives. The theoretical model was validated by confirmatory factor analysis (CFA) using PLS. Out of 19 hypotheses developed during the study, 11 of them were very strongly supported, 4 strongly supported, 1 moderately supported and 3 unsupported.

Key words: Behavioural intention, innovation diffusion, technology acceptance, mobile wallet.

1. Introduction

Rae Steinbach (2016) predicts that the mobile wallet is transforming consumer culture. It is a dramatic event in digital revolution towards throwing out throw old, ratty wallet, cut up those credit cards. The Convergence of Wireless telecommunication development, multi-functional mobile phone devices and the Payment system developments has created the biggest possibility of transacting in the real world in methods other than cash and card. Google (2011) captures this essence in its Vision statement for its Google Wallet "In the past few thousand years, the way we pay has changed just three times—from coins, to paper money, to plastic cards. Now we're on the brink of the next big shift". The next big shift is mobile wallet. Mobile commerce started right after the mobile technology evolved to Short Messaging Services (SMS) capabilities. Carr (2007) identified each of them.

[1]Correspondence to A.Seetharaman, E-mail: seetha.raman@spjan.org

1.1 Payment Systems development

The exchange of financial value had evolved from coins, notes and other instruments to sophisticated e-payment systems, by the end of 20th century. While Jewson (2001) explained, about the involvement of commerce in the exchange of value, Maamar (2003) offered a complete new idea of commerce which can be associated with one of the four types of exchanges: bargaining, bidding, auctioning and clearing.

At the heart of the e-commerce system is the electronic payment systems or e-payments. Raja, Velmurugan and Seetharaman (2008) define payment system as the infrastructure which comprised of institutions, instruments, rules, procedures, standards and techniques, established to affect the transfer of monetary value between all the parties. Further to that Raja et al. (2008) cite Humphrey, Pulley and Vesala (1996) to define E-payments as "payments that are initiated, processed and received electronically".

Lee, Yu and Kuo (2001) tried to analyse and compare these different electronic payment systems on technological aspect, economic aspect, social aspect and regulatory aspect and concluded credit cards or virtual cards are widely accepted by consumers and merchants. Earlier, Treese and Stewart (1998) also had confirmed the view; credit card is the most widely used method of payment for e-commerce transactions.

Jentzsch and Miniotas (1999) classified eCommerce into four broad categories – Business-to-Customer (B2C), Business-to-Business (B2B), Business-in-Business (B1B), and Consumer-to-Consumer (C2C). Tarasewich, Nickerson, and Warkentin (2002) defined mCommerce as all commercial transaction conducted through communications networks that interface with wireless (or mobile) devices. Jelassi and Enders (2008) define m-commerce as "Mobile e-commerce, or m-commerce, is a subset of electronic commerce.

Ally (2001) indicates SSL allowed connections to be established, in which both parties are authenticated to each other or only the server is authenticated or entirely both parties remain anonymous in connections.

As a logical sequence of events on mobile payment technologies, Heijden (2002) defined mobile payments in line with Shon and Swatman (1997) as "any conventional or new payment system which enables financial transactions to be made securely from one organization or individual to another over a mobile network".

Linck, Pousttchi, and Wiedemann (2006) differ from the above definition stating the mobile payments as an electronic procedure where the payer employs mobile communication techniques in conjunction with mobile devices for initiation, authorization or realization of a payment. Dahlberg, Mallat, Ondrus and Zmijewska (2007) define Mobile payments as "payments for goods, services, and bills with a mobile device (such as a mobile phone, smart-phone, or personal digital assistant (PDA)) by taking advantage of wireless and other communication technologies." Carr (2007) cites Au and Kaufmann (2007) in defining m-payments as "any payment where a mobile device is used to initiate, authorize and confirm an exchange of financial value in return for goods and services".

Mobile Payments can be classified into three broad categories as suggested by McKitterick and Dowling (2003). They are Mobile Operator Payment, Out-of-Band Payment

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and Proximity Payment. Mobile Operator Payments are those payments made by consumers to Network operators for "Pay per use" model services. Here, the content and the payment channel are the same and hence called "in-band".

2. Literature Review

The literature review starts from the very basic question, "Why people decide to accept or reject a specific technology?" To answer this question, a study of behavioural intention, as a dependant variable is required. The standard reference model is "Technology Acceptance Model (TAM)" by Davis (1989). Yang (2005) admired at Technology Acceptance Model (TAM) as one of the most parsimonious, yet robust, model in explaining ICT.

2.1 Perceived usefulness and perceived ease-of-use

TAM model suggests that when users are presented with a new technology, Perceived Usefulness (PU) and Perceived ease-of-use (PEOU) are the two factors that influence their decision about how and when they will use the new technology. These two variables influence Behavioural Intention to use (BI) a system, which, in turn, correlates with actual use. TAM model itself is an adaptation of the "Belief, Attitude, Intention and Behaviour" by Fishbein and Ajzen (1975) and "Theory of Reasoned Action (TRA)" by Fishbein and Ajzen (1980), that tried to explain and predict behaviour of people in a specific situation. In the Venkatesh et al. (2003) expanded the TAM model in their Unified Theory of Acceptance and Use of Technology (UTAUT). Although UTAUT has already been validated in previous studies, it does not seem to be easily adapted to mobile wallet. Zmijewska, Lawrence and Steele (2004b) argue the model is best used to measure technology acceptance in companies and not in public domain. The reason is that, some of the criteria suggested to measure 'social influence' include help of the senior management and organizational support for the new technology. As mobile wallet payments remain in the everyday life domain, the use of TAM to predict user acceptance in this field seems more appropriate.

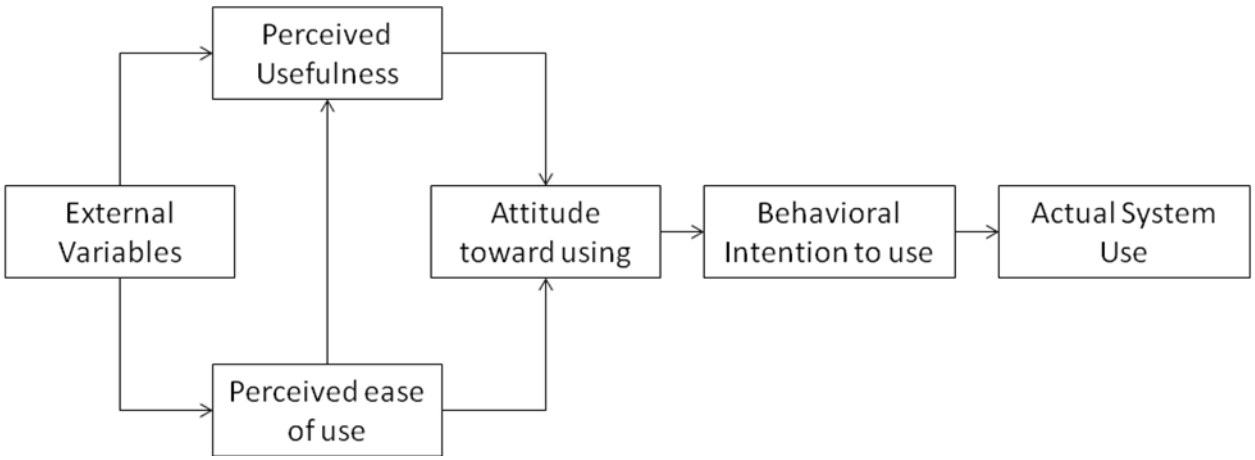

Figure 1: Technology Acceptance Model

H1: A users' perceived usefulness of mobile wallet has a positive effect upon his/her behavioral intention to use mobile wallet.
H2: A users' perceived ease of use of mobile wallet has a positive effect upon his/her behavioral intention to use mobile wallet.
H3: A users' perceived ease of use of mobile wallet has a positive effect on users' perceived usefulness of mobile wallet.

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2.2 Innovativeness

Rogers (1962) presented the "Innovation Diffusion Theory (IDT)", to explain how, why and at what rate new ideas and technology spread through cultures. He stated that diffusion is a process by which an innovation is communicated through certain channels over time among the members of a social system. Since Singapore always adopts high tech culture, the choice of innovativeness as an independent variable is more relevant for this study. Time is involved in diffusion in many ways. One of the ways time is involved in diffusion is in the innovativeness of an individual or other unit of adoption. Innovativeness is the degree to which an individual is relatively earlier in adopting new technology or ideas than other members of a social system. There are five adopter categories as given by Rogers (1995), namely Innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%) and late adopters or laggards (16%). Innovation Diffusion Theory (IDT) stresses five attributes namely relative advantage to improve innovation over generations, compatibility to meet existing values, past experience and expectations of early adopters, complexity in using technology intuitively, trialability in exploring the innovation on experimental basis and observability towards positive effects of innovation perceived by others. Chen and Adams (2005) have used both TAM and IDT constructs to explain the acceptance factors.

H4: Innovativeness of the user has a positive effect upon his/her behavioral intention to use mobile wallet.

2.3 Are TAM and IDT outdated?

The independent variables namely perceived usefulness, perceived ease-of-use and innovativeness are derived from two models TAM and IDT. Are these models outdated? A close review by Chen (2008) established that TAM (Davis, 1989) and IDT (Rogers 1995) are among the most influential theories and proven highly successful in empirical studies (e.g. Taylor and Todd, 1995; Igbaria, Guimarages and Gordon, 1995; Moore and Bembasat, 1996; Igbaria et al., 1997; Karahanna, Straub and Chervany, 1999; Gefen and Straub, 1997, 2000; Devaraj, Fan and Kohli, 2002; Koufaris, 2002; Chen, Gillenson and Sherrel, 2004; Lu, Wang and Yu, 2007). To strengthen the view, TAM and IDT are not outdated and continue to be among the most influential theories as seen by El-Gohary (2010) and Eid (2011) who have applied these models in their articles.

2.4 Critical Mass

The variable "Critical Mass" is derived from theory on network externalities. Hort, Gross, and Fleisch (2002) and later Zmijewska and Lawrence (2005) identified the Network Externalities Theory as one of the factors that explained the adoption of innovation such as Mobile Wallet. Hort et al (2002), while explaining the difference between the old industrial economy and the new information economy, stated that the old economy is driven by economies of scale whereas the new economy is driven by economies of networks.

The question then arises, in a competitive situation, how a new technology or innovation gather the required critical mass and creates a new sense of value? This question is answered by Network Externalities (Effect) theory put forward by Katz and Shapiro (1985) which on a high level is "success begat more success". The best example of network externalities working for the better of every participant in the social system, as explained by Chakravorti (2003), would be credit card networks. Externalities are the effect that one user of a good or service has on the value of that product to other people in a positive or negative way without receiving or paying any compensation.

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Chen (2008) quote a Dunn & Company survey done in 2007, where 83% of the respondents believed that mobile payments would reach a critical mass in the coming years. Jarupunphol and Mitchell (2002a) in their reasoning for the failure of SET, mention "lack of end-user participation" or non-existence of network externalities. Turban and Brahm (2000) reason out another aspect "A key element for reaching a critical mass of users is interoperability". Sahut (2008) discusses the effect of Network Externalities on the electronic wallet. This is on the basis of ground work that rolling stone gathers no mass, whereas snowballing effect can create a critical mass. Though mention was made about critical mass in the previous literature, no authors treated critical mass as a variable.

H5: Critical mass of merchants, payment systems, banks and financial institutions and payment instruments made available for mobile wallet, all of these together has a positive effect upon users' perceived usefulness of mobile wallet.

H6: Critical mass of merchants, payment systems, banks and financial institutions and payment instruments made available for mobile wallet, all of these together has a positive effect upon users' behavioral intention to use mobile wallet.

2.5 Availability of Alternatives

Dahlberg, Mallat, Ondrus and Zmijewska (2006) expanded the acceptance framework by introducing the five-force model of Porter (1998). For example, cash is a very strong alternate for electronic payment products. When the threat from the substitute product is very great, then the adoption of the product in discussion will be limited and there will be no network effect. The traditional wallet which holds different cards namely credit card, debit card, transport card, membership card, identity card, etc., has difficulty in storage and physically handling them, whereas the mobile wallet can hold all-in-one and easy to use, leading to behavioural intention to use mobile wallet.

H7: Lack of availability of effective alternatives has a positive effect upon his/her intention to use mobile wallet.

2.6 Transaction Security and Trust

Security and trust are hygiene factors. Lack of security and trust will be perceived as barriers to adoption of the mobile wallet. Zmijewska and Lawrence (2005) argued developing a system and brand that people will trust is a necessary determinant of success. In a survey by Abrazhevich (2001), 98.4% of the respondents identified security as "Important or very important", 97.6% respondents identified trust system is introduced "only by an established organization" and to prove trust is a hygiene factor, 94.4% respondents opined that they will refrain from using a non-trustworthy system. Significant amount of functionality of mobile wallet is around payment systems. Hassler (2001) summarized the electronic payment systems into the four subcategories, namely payment authentication requiring proof of identity for payer and payee, payment integrity ensuring the prevention of unauthorized modification of payment data, payment authorization ensuring prevention of unauthorized withdrawals without explicit permission of account holders and payment confidentiality ensuring absolute secrecy of the payment transaction.

Heijden (2002), Constantiou et al. (2004), Dahlberg and Öörni (2006), Ondrus and Pigneur (2006a), Ondrus and Pigneur (2006b) and Sahut (2008) all included security in their construct and found it was a very important driver of the mobile payments. Gefen, Karahanna and Straub (2003), Mallat and Tuunainen (2005), Dahlberg and Öörni (2006) and Pousttchi and Wiedemann (2007) included trust in their construct and found trust come out strongly in the acceptance model. Linck, Pousttchi, and Wiedemann (2006) analyzed security from the

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dimensions of objective and subjective security. They defined objective security as a concrete technical characteristic, when a certain technological solution responds to all of five security objectives namely, confidentiality, authentication, integrity, authorization and non-repudiation (Merz 2002).

Linck, Pousttchi, and Wiedemann (2006) quote Chari, Kermani, Smith and Tassiulas (2000) to emphasis the importance of security in a mobile world. Trust is defined by Karnouskos, Hondroudaki, Andra, and Csik (2004) as a statement of belief. Trust characteristics were classified by Eze, Gerald-Goh, Ademu and Tella (2008) as competence, benevolence, integrity and predictability. They also quote Ondrus and Pigneur (2006a) "Trust is more of a basic requirement than a competitive advantage." Ding and Hampe (2003) reason out lack of trust in non-bank organization offering mobile payment solutions caused some of the earlier mobile payment system failures. Hence it is included as a separate independent variable that influences the behavioral intention.

H8: A users' perceived transaction security (confidentiality, integrity, authentication, non-repudiation and authorization) of payment transaction using mobile wallet has a positive effect upon his/her perceived ease of use of mobile wallet.

H9: A users' perceived transaction security (confidentiality, integrity, authentication, non-repudiation and authorization) of payment transaction using mobile wallet has a positive effect upon his/her behavioral intention to use mobile wallet.

H10: A users' perceived trust in mobile wallet transactions has a positive effect upon users' perceived transaction security of payment transaction using mobile wallet.

H11: A users' perceived trust in mobile wallet transactions has a positive effect upon his/her behavioral intention to use mobile wallet.

2.7 Privacy and Anonymity

Chari, Kermani, Smith and Tassiulas (2000) ruled out complete user privacy in any server centric and user centric scenario. Network operators would know the physical location of the mobile client device in all applications based on mobile phones. Similarly, Tarasewich, Nickerson, and Warkentin (2002) raised the question on the role of location technologies, especially the GPS, in wireless communication and how users could positively be identified without undue intrusion on their time and privacy. Hort, Gross, and Fleisch (2002) describe anonymity as "which data received by which participant".

Looking at privacy from a transaction perspective, Hassler (2001) defines privacy as the ability to understand protected data by authorized principals only. Protected data should not be readable by others. Along the same lines, Karnouskos, Hondroudaki, Andra, and Csik (2004) defined privacy as protection of sensitive user data.

Chen (2008) included privacy concerns as one of the constructs in addition to TAM to explain the acceptance model. Chen (2008) quotes Smith, Milberg and Burke (1996) to list the various aspects of the privacy concerns on personal information namely, collection of too much personal information by companies, lack of protection leading to unauthorized access, errors and inaccuracies in database and secondary use of data for other purposes without consumers' consent. On the other hand, many researchers, Heijden (2002), Ding and Hampe (2003), Nambiar, Lu and Liang (2004) and Carr (2007) have combined privacy with security in their construct. Zmijewska, Lawrence and Steele (2004b) argue that privacy was already included in trust and cost dimensions and therefore there is no need for a separate category. Similarly, Linck, Pousttchi, and Wiedemann (2006) considered anonymity as an important

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security feature. In their empirical study, anonymity could be nearly disregarded in consideration of security, from customers' viewpoint.

Raja, Velmurugan and Seetharaman (2008) make an observation regarding privacy and anonymity from a legal perspective as privacy must be regarded as a political right that consumers enjoy and ought to be respected.

H12: Privacy & anonymity in a mobile wallet has a positive effect upon users' perceived ease of use of mobile wallet.

H13: Privacy & anonymity in a mobile wallet has a positive effect upon users' perceived transaction security of payment transaction using mobile wallet.

2.8 Flexibility

Amberg, Hirschmeier, and Wehrmann (2003) proposed flexibility also as a construct in the acceptance model. Flexibility should be available for the consumers to switch their mobile devices with ease without having to spend too much time or effort in transferring data or application from old mobile device to new mobile device.

H14: A users' perceived flexibility of mobile wallet system has a positive effect upon his/her behavioral intention to use mobile wallet.

2.9 Cost of Transaction

Milton Friedman (1953), a Nobel laureate gave the narrower definition of rational choice theory explaining an individual behaviour of balancing cost against benefits to arrive at action that maximises personal advantage. Gary Becker (1976), another Nobel laureate and an early proponent of applying rational actor model more widely, indicated the rationality as the most cost-effective means to achieve a specific goal. Despite criticisms from another Nobel laureate Amartya Sen against rational model, these two Nobel laureates made significant contributions to rationality as a social and economic behaviour which are very related to behaviour intention.

Hort, Gross, and Fleisch (2002) define Cost as the sacrifice that a customer has to give away. Costs involve price and relationship costs. Cost of transaction impacts affordability. Jarupunphol and Mitchell (2003) support this view by stating the cost of implementation and usage of the system must be affordable for both consumers and merchants. They further quoted Jarupunphol and Mitchell (2002b) about the unwillingness of the consumers to pay for a digital certificate in order to conduct SET transaction. Treese and Stewart (1998) expressed similar view where merchants would also not wish to invest significantly in engineering e-payment infrastructure.

Amberg, Hirschmeier, and Wehrmann (2003) proposed cost as an acceptance factor. Similarly, Tarasewich, Nickerson, and Warkentin (2002) questioned the willingness of the businesses to pay the high initial cost of establishing the necessary wireless infrastructure. Devaraj, Fan and Kohli (2002) showed perceived ease of use as a strong determinant of satisfaction in total cost analysis.

Heijden (2002) discusses cost relative to the substitutes and argue that there is additional cost to customers in electronic or mobile payments, and switching back to cash is very easy, which is simple, fast and costs nothing to the customer. Mallat and Tuunainen (2005), in their study of Merchant Adoption of Mobile Payment Systems, found that high costs are a barrier for merchant adoption of mobile payments. Humphrey, Kim and Vale

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(2001) noted the sensitiveness of the payment users to relative prices that reflect the relatively lower cost of electronic payments. Cheong, Park and Hwang (2004) group cost into three categories namely, continuity cost, sunk cost and learning cost. Their study revealed that continuity cost and sunk cost have no significant influence in developing intentions to use mobile payments. In view of the varied opinions on cost, the authors decided to test the relationship of nominal transaction cost with transaction security and cost with perceived usefulness and perceived ease of use.

H15: A nominal cost of transaction has a positive effect upon a users' perceived usefulness of the mobile wallet.

H16: A nominal cost of transaction has a positive effect upon a users' perceived ease of use of the mobile wallet.

H17: A nominal cost of transaction has a positive effect upon a users' perceived transaction security of payment transaction using mobile wallet.

2.10 Transaction Speed

Ondrus and Pigneur (2007) mentioned about speed that some technologies (e.g., RFID and NFC) are bringing better and speedier performance than traditional payment cards. Massoth and Bingel (2009) define speed in terms of authentication as time one single transaction takes and by how many transactions can be done in a certain time span. Carr (2007) mentioned that the speed at which m-payments are executed must be acceptable to customers and merchants. Turban and Brahm (2000) mentioned speed of a transaction is a very important criterion for payment transactions especially in transport industry. In Singapore, buses and rails maintain incredible speed at entry and exit point by using Transit Link smart card payment. For example, Zmijewska and Lawrence (2005) and Chen and Adams (2005) included transaction speed with ease of use and Pousttchi (2003) included transaction speed with convenience. The authors of this paper decided to test transaction speed with perceived usefulness and perceived ease of use constructs.

H18: A users' perceived transaction speed has a positive effect upon users' perceived usefulness of mobile wallet.

H19: A users' perceived transaction speed has a positive effect upon users' perceived ease of use of mobile wallet.

3. Data and methods

Exploratory research design was utilized to design a structured questionnaire to study the users' behavioural intention to use mobile wallet, test the hypotheses and to gain further insights into consumer intentions and behaviours.

It was decided to collect the data from consumers residing in Singapore. The questionnaire consists of four sections namely mobile usage, mobile wallet, factors influencing mobile wallet usage and demography. A pilot test was conducted by interviewing 50 mobile phone users from various industries such as information technology, communications, finance, academics, retail, shipping and manufacturing, etc. Exploratory factor analysis (EFA) was carried out on the pilot test responses. The final survey was conducted as a web survey. An e-mail invitation to complete the online survey was sent to 400 participants, out of which 309 responses were received. Incomplete responses and otherwise unusable responses were discarded resulting in ultimate sample size of 227. Demographic breakdown of the respondents is presented in table 1 and mobile usage of respondents in table 2.

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Table 1: Demographic breakdown of respondents (n=227)

Measure	*Items*	*Frequency*	*Percent*
Gender	Male	180	79.3
	Female	47	20.7
Age	18 to 24	6	2.6
	25 to 29	48	21.1
	30 to 34	67	29.5
	35 to 39	64	28.2
	40 to 44	21	9.3
	45 to 54	16	7.1
	55 to 64	4	1.8
	65 and above	1	0.4
Residential Status	Singapore Citizen	28	12.3
	Singapore PR	110	48.5
	Employment Pass / Work Permit	71	31.3
	Student Pass	17	7.5
	Visitor	1	0.4
Highest Education	GCE 'O' levels	1	0.4
	GCE 'A' levels	4	1.8
	Diploma	5	2.2
	Graduate	96	42.3
	Post Graduate	117	51.5
	Doctorate	4	1.8
Occupation	Professional	80	35.2
	Executive Management	6	2.6
	Senior Management	12	5.3
	Middle Management	47	20.7
	Managers / Executives	50	22.0
	Self Employed	2	0.9
	Business Owner	1	0.4
	Student	19	8.4
	Others	10	4.5
Marital Status	Single	56	24.7
	Married	169	74.4
	Others	2	0.9
Total Household Income	< 3000	28	12.3
	3001 – 5000	42	18.5
	5001 – 7000	52	22.9
	7001 – 10000	53	23.4
	10001 – 13000	35	15.4
	13001 – 18000	9	4.0
	> 18000	8	3.5

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Table 2: Descriptive statistics of respondents' mobile usage (n=227)

Measure	*Items*	*Frequency*	*Percent*
Own more than one mobile line	Yes	79	34.8
	No	148	65.2
I use my primary mobile more often for	Personal use	169	74.4
	Work related	58	25.6
My primary phone bill Payment Type	Pre-Paid	57	25.1
	Post Paid	170	74.9
Average Monthly phone bill	< $30	24	10.6
	$31 - $60	59	26.0
	$61 - $90	60	26.4
	$91 - $120	42	18.5
	> $120	42	18.5
Have you used Mobile Banking in the past six months	Yes	129	56.8
	No	98	43.2

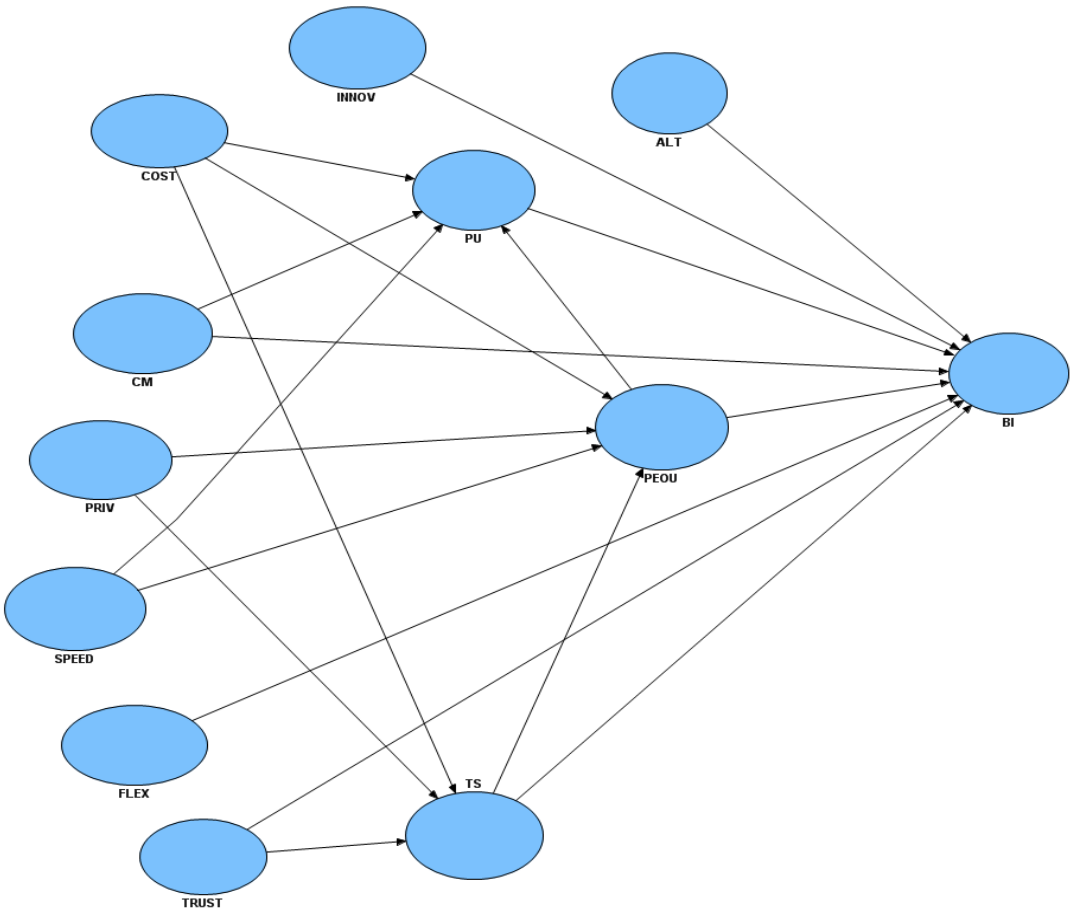

Figure 2: Research Model

3.1 Statistical techniques or tools

SmartPLS software http://smartpls.com (M3) (Ringle et al., 2005) which is based on path modelling was used to assess the validity and reliability of the instrument and then the bootstrapping (Chin 1998; Tenenhau et al, 2005; and Wetzels et al., 2009) with 200 re-samples were used to generate the standard error of the estimate and t-values.

3.2 Assessment of the Measurement Model

We conducted a confirmatory factor analysis (CFA) to assess reliability, convergent validity, and discriminant validity of the scales. As shown in the table 3 and 4, most item loadings were larger than 0.5 (significant at $p < 0.01$). All Average Variance Extracted (AVEs) exceeded 0.5 (Bagozzi & Yi, 1988). The composite Reliability (CRs) exceeded 0.7 (Gefen, Straub, & Boudreau, 2000) while the Cronbach alpha values exceeded 0.7 (Nunnally, 1978). Thus, we ensured convergent validity. In addition, the square root of the AVE was tested against the inter-correlations of the construct with the other constructs in the model to ensure discriminant validity (Chin, 1998, 2010; Fornell & Larcker, 1981) and all the square root of the AVE exceeded the correlations with other variables. Thus, the measurement model was considered satisfactory. Next, we proceeded to test the hypotheses generated for this research.

Table 3: Result of measurement model

Construct	*Item*	*Loadings*	*AVE*	*CR*	*Cronbach α*
Alternatives	ALT1	0.807	0.719	0.911	0.870
	ALT2	0.843			
	ALT3	0.850			
	ALT4	0.889			
Behavioural Intention			0.878	0.966	
	BI1	0.852			0.953
	BI2	0.963			
	BI3	0.974			
	BI4	0.955			
Cost Impact	CI1	0.848	0.785	0.936	0.909
	CI2	0.867			
	CI3	0.921			
	CI4	0.907			
Critical Mass	CM1	0.957	0.921	0.983	0.978
	CM2	0.967			
	CM3	0.964			
	CM4	0.966			
	CM5	0.944			
Flexibility	FLEX1	0.992	0.948	0.973	
	FLEX2	0.955			
Innovativeness	INNO1	0.977	0.958	0.986	0.978
	INNO2	0.983			
	INNO3	0.976			
Perceived Ease of Use	PEU1	0.990	0.981	0.990	0.980
	PEU2	0.990			

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Table 3: Result of measurement model (cont.)

Construct	*Item*	*Loadings*	*AVE*	*CR*	*Cronbach α*
Privacy	PRIV1	0.887	0.794	0.921	0.871
	PRIV2	0.905			
	PRIV3	0.881			
Perceived Usefulness	PU1	0.981	0.961	0.987	0.961
	PU2	0.987			
	PU3	0.972			
Speed	SPEED1	0.987	0.973	0.986	0.972
	SPEED2	0.986			
Trust	TRUST1	0.949	0.901	0.973	0.963
	TRUST2	0.964			
	TRUST3	0.966			
	TRUST4	0.918			
Transaction Security	TS1	0.821	0.785	0.978	0.975
	TS2	0.888			
	TS3	0.842			
	TS4	0.896			
	TS5	0.904			
	TS6	0.939			
	TS7	0.924			
	TS8	0.936			
	TS9	0.907			
	TS10	0.907			
	TS11	0.796			
	TS12	0.861			

Note: AVE = Average Variance Extracted, CR = Composite Reliability

Next, we proceeded to test the discriminant validity. The discriminant validity of the measures (the degree to which items differentiate among constructs or measure distinct concepts) was assessed by examining the correlations between the measures of potentially overlapping constructs. Items should load more strongly on their own constructs in the model, and the square root of the average variance shared between each construct and its measures should be greater than the correlation between the construct and other constructs (Compeau, Higgins & Huff, 1999). As shown in Table 4, the correlations for each construct is less than the square root of the average variance extracted by the indicators measuring that construct indicating adequate discriminant validity. In total, the measurement model demonstrated adequate convergent validity and discriminant validity.

3.3 Assessment of the Structural Model

Next, we proceeded with the path analysis to test the hypotheses generated. Figure 3 and Table 5 shows the results. Out of the 19 hypotheses 16 were supported except for 3 (H2, H11 and H12). The variance explained ranged from 0.842 to 0.925 (see Figure 3).

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Table 4: Discriminant validity of constructs

	ALT	*BI*	*CM*	*COST*	*FLEX*	*INNOV*	*PEOU*	*PRIV*	*PU*	*SPEED*	*TRUST*	*TS*
ALT	**0.848**											
BI	0.727	**0.937**										
CM	0.718	0.764	**0.960**									
COST	0.745	0.769	0.796	**0.886**								
FLEX	0.567	0.600	0.667	0.669	**0.974**							
INNOV	0.695	0.673	0.661	0.686	0.577	**0.979**						
PEOU	0.688	0.706	0.722	0.683	0.632	0.591	**0.990**					
PRIV	0.655	0.574	0.698	0.684	0.606	0.657	0.561	**0.891**				
PU	0.689	0.772	0.755	0.725	0.677	0.628	0.821	0.570	**0.980**			
SPEED	0.645	0.695	0.710	0.646	0.631	0.567	0.775	0.579	0.786	**0.986**		
TRUST	0.626	0.695	0.695	0.626	0.602	0.563	0.727	0.551	0.735	0.727	**0.949**	
TS	0.749	0.802	0.803	0.770	0.697	0.685	0.799	0.687	0.772	0.777	0.862	**0.886**

Note: Diagonals represent the square root of the average variance extracted while the other entries represent the squared correlations

Table 5: Path coefficients and hypothesis testing

Hypothesis	*Relationship*	*Coefficient*	*t-value*	*Supported*
H1	PU → BI	0.354	4.121***	YES
H2	PEOU → BI	-0.086	1.051	NO
H3	PEOU → PU	0.400	5.734***	YES
H4	INNOV → BI	0.110	2.043**	YES
H5	CM → PU	0.147	2.166**	YES
H6	CM → BI	0.176	2.113**	YES
H7	ALT → BI	0.136	1.831**	YES
H8	TS → PEOU	0.452	5.036***	YES
H9	TS → BI	0.408	3.648***	YES
H10	TRUST → TS	0.588	16.887***	YES
H11	TRUST → BI	-0.051	0.591	NO
H12	PRIV → PEOU	-0.061	1.112	NO
H13	PRIV → TS	0.162	4.335***	YES
H14	FLEX → BI	-0.080	1.299*	YES
H15	COST → PU	0.168	3.105***	YES
H16	COST → PEOU	0.157	2.380***	YES
H17	COST → TS	0.279	6.851***	YES
H18	SPEED → PU	0.276	4.193***	YES
H19	SPEED → PEOU	0.401	4.755***	YES

Note: ***p< 0.01, **p< 0.05, *p< 0.1

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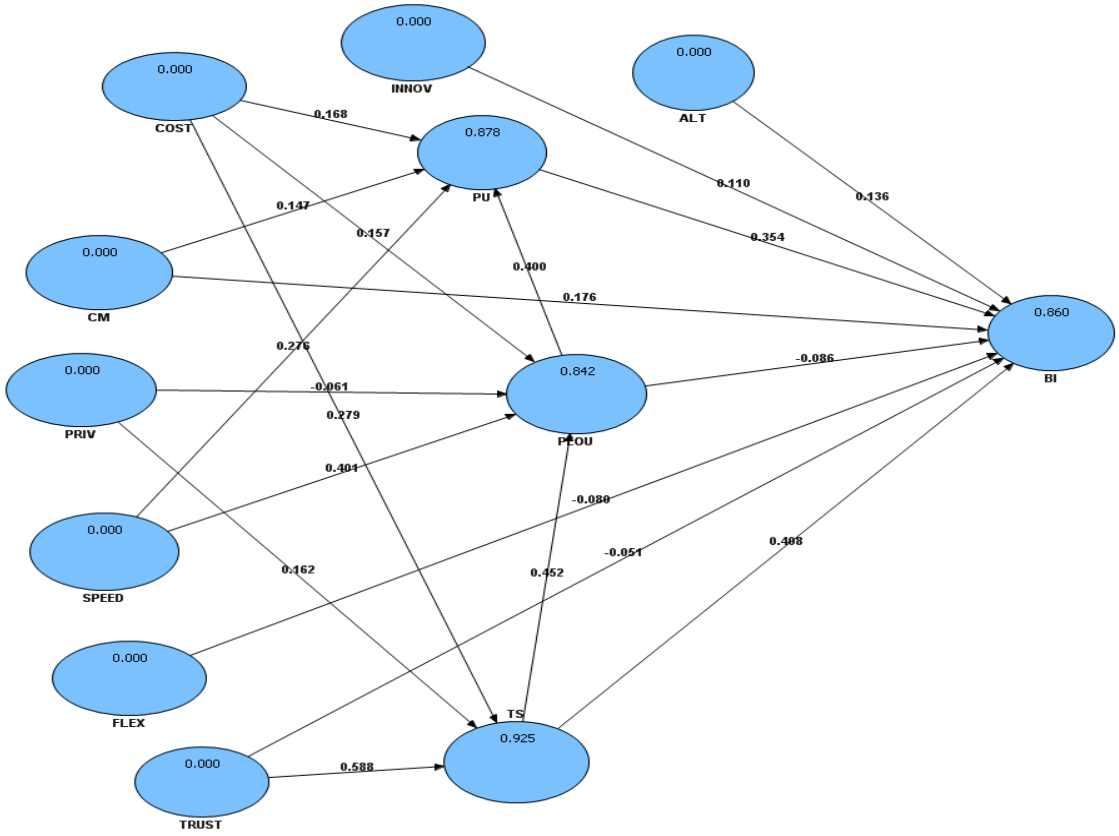

Figure 3: Structural Model

3.4 Assessment of Fit

We also conducted a global fit measure (GoF) assessment for PLS path modelling, which is defined as the geometric mean of the average communality and average R^2 (for endogenous constructs; Tenenhaus et al., 2005) following the procedure used by Akter et al. (2011). Following the guidelines of Wetzels et al. (2009), we estimated the GoF values (see formula), which may serve as cut-off values for global validation of PLS models. The GoF value of 0.88 (R^2 was 0.876, average AVE was 0.884) for the model, which exceeds the cut-off value of 0.36 for large effect sizes of R^2. As such, it allows us to conclude that our model has better explaining power in comparison with the baseline values (GoF_{small} =0.1, GoF_{medium} =0.25, GoF_{large} =0.36) (Akter et al., 2011). It also provides adequate support to validate the PLS model globally (Wetzels et al., 2005).

This study has a few limitations. First, the demographics of the sample are very different from the demographics of the population. For example, only 18.1% of the respondents were women whereas the Singapore female population is at 50.5%. Despite our earnest efforts to include a range of individuals representing different sectors of mobile phone user, our respondents were mainly from information technology, communication and financial sector. Similarly, for the residential status, 48.5% of respondents were Singapore PRs whereas the Singapore Citizens were only 28%. Second, this study is purely on the consumer side of the mobile wallet market. Though there are few variables that covered the merchant side of the market, the study did not address the role of merchants in adoption of the mobile wallet. Hence, future research could cover factors influencing merchant adoption of transactions using mobile wallet.

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4. Conclusion

A significant contribution of this study is the clear-cut definition of Mobile Wallet. Prior to our definition there were many vague explanations of mobile wallet. Our definition will set rest all other conflicting opinions about mobile wallet. While studying network externalities, we identified a variable on critical mass, which was not deeply and extensively touched by any other author. From the measurement model also, we can safely conclude that critical mass is a very reliable indicator of behavioural intention. Critical mass is an additional theoretical contribution to the existing body of knowledge. Another variable which was not dealt with by any other author is the availability of alternatives. This has been looked into deeply and it has a strong influence over behavioural intention. Nominal transaction cost with respect to transaction security was not looked at before. Our results confirmed that nominal transaction cost has very strong influence over perceived usefulness, perceived ease of use and also transaction security, thus strengthening three influencing variables.

The objectives of the study were centred on consumer thinking and feeling about the mobile wallet and ascertain the factors influencing consumers' intention to use mobile wallet. Due to this objective, our study focused on behavioural intention to use mobile wallet as a primary indicator of consumer acceptance. The study highlighted that perceived usefulness and transaction security have a very strong influence over behavioural intention, whereas innovativeness, critical mass and lack of availability of alternatives have a strong influence over behavioural intention and finally flexibility has a moderate influence over behavioural intention. Finally, the network of mobile wallet users would not grow if there isn’t a critical mass of users. Industry players should look for ways to create the critical mass which would also push the usage of the mobile wallet payment method over other traditional methods such as cash and card. While transaction security has a strong influence on behavioural intention, surprisingly trust and perceived ease of use had no direct influence on behavioural intention.

While perceived ease of use, transaction cost and speed of transaction had struck a very strong influence on perceived usefulness, critical mass had a strong influence over perceived usefulness. Industry players could improve the perceived usefulness of the mobile wallet by demonstrating a faster transaction speed at a nominal transaction cost and also showing to the consumers and merchants that there is momentum building up for a critical mass or show such a critical mass of users are already available for use of mobile wallet.

Transaction security, nominal cost of transaction and speed of transaction had struck a very strong influence on perceived ease of use, whereas privacy had no influence on perceived ease of use.

Trust, privacy and nominal transaction cost struck a very strong influence on transaction security. Industry players should thus raise the level of awareness of trust and privacy in mobile wallet transactions to improve the perception of transaction security and in turn improving the behavioural intention to use mobile wallet. HandePay (2017) predicts that Mobile wallet use will increase over the next five years. What next is an exciting new research area?

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