Predicting consumer intention to use mobile service

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Abstract. *Advances in wireless technology have increased the number of people using mobile devices and accelerated the rapid development of mobile service (m-service) conducted with these devices. However, although many companies are today making considerable investments to take advantage of the new business possibilities offered by wireless technology, research on mobile commerce suggests potential consumers may not adopt these m-services in spite of their availability. Thus, there is a need for research to identify the factors that affect consumer intention to use m-services. Based on the technology acceptance model (TAM), theory of planned behaviour (TPB) and Luarn & Lin's 2005 mobile banking acceptance model, the current research respecifies and validates an integrated model for predicting consumer intention to use m-service by adding one trust-related construct ('perceived credibility') and two resource-related constructs ('self-efficacy' and 'perceived financial resources') to the TAM's nomological structure and re-examining the relationships between the proposed constructs. Data collected from 258 users in Taiwan were tested against the research model using the structural equation modelling approach. The results strongly support the proposed model in predicting consumer intention to use m-service. Several implications for information technology/information system acceptance research and m-service management practices are discussed.*

Keywords: mobile service, theory of planned behaviour, technology acceptance model, perceived resources, computer self-efficacy

INTRODUCTION

Mobile service (m-service), or electronic service (e-service) using mobile devices (e.g. cellular phones, hand-held or palm-sized computers, or vehicle-mounted interfaces) and wireless telecommunications networks, has become a hot topic in the information systems (IS) and mar-

keting research community. Lately, the potentialities of m-service applications are leading many organizations to spend huge sums of money on these technologies. M-service provides values which are not available to traditional wired electronic commerce (e-commerce), such as ubiquity, personalization, flexibility and dissemination (Siau *et al*., 2001). Delivering value-added, interactive, and/or location-based m-services (e.g. banking, content download, emergency/roadside assistance and wireless coupon) to customers seems increasingly important for gaining a competitive edge in the mobile marketplace by strengthening relationships with key customers.

Predictions, based on anecdotal and empirical evidence on the future popularity and volume of m-service, have been widely presented in academic literature and in the business and technology press (e.g. Varshney & Vetter, 2000; Vetter, 2001; Anckar & D'Incau, 2002). Although many authors and research firms believe the demand for m-service will skyrocket over the next 5 years, others have been far more conservative in their predictions. Anckar & D'Incau (2002) argued that the popularity of m-service could not be measured by the popularity of mobile devices, just as the popularity of wired e-commerce cannot be measured by the popularity of computers, as has been proven. Additionally, the collapse of large numbers of dot-com companies has required managers to relearn that profits indeed do matter (Rosenbloom, 2002) and that the traditional laws of marketing were not rescinded with the arrival of the m-service era.

Although a growing body of literature, matched by limited empirical evidence, has highlighted the valuable elements of m-service (Clarke, 2001; Anckar & D'Incau, 2002), the consumers' primary reasons for adopting and intending to adopt m-services remain unclear (cf. Urbaczewski *et al*., 2002; Pedersen *et al*., 2002; Pedersen & Ling, 2003; Lu *et al*., 2003; Meso *et al*., 2005). As Pedersen & Ling (2003) noted, 'Even though traditional Internet services and m-services are expected to converge into mobile Internet services, few attempts have been made to apply traditional adoption models in IS research to explain their potential adoption'. However, building successful strategies for the mobile marketplace unquestionably begins by understanding the factors affecting consumer intentions to use m-service systems. Despite all the efforts aimed at developing better and more efficient m-service systems in Taiwan, these systems either have been ignored by consumers, or are seriously underused, regardless of their availability. In order for wireless-based services to be effectively used in the mobile commerce (m-commerce) environment, m-service providers need to know the critical factors that affect a customer's intention to adopt m-service. In the m-service industries, the high cost of acquiring customers renders many customer relationships unprofitable during the early years. Without mass adoption, even the best-designed m-service business model will soon fall apart (cf. Anckar & D'Incau, 2002; Pedersen *et al*., 2002; Pedersen & Ling, 2003).

Therefore, the objective of this research is to understand the acceptance of m-service from the perspective of the consumers, and to identify the factors that can predict their intention to use business-to-consumer (B2C) m-service systems. Given that cellular phones, palm-sized computers and vehicle-mounted interfaces are all very different technologies and therefore may have very different adoption and acceptance criteria, and given that cellular phones are the most popular devices for using m-services, this study will only focus on the use of m-

services through cellular phone devices. Additionally, the meaning of m-services in this study refers to a set of chargeable B2C m-service transactions managed by a telecommunication company, such as send/receive emails, listen to/download music, download graphics/animation, mobile shopping, read/receive news, play online games, stock trading, book travel tickets, mobile fortune-telling, friend finding, buy books, take part in internet auctions and mobile banking (m-banking). In Taiwan, consumers usually need to join in an m-service group (e.g. i-Mode) supported by a telecommunication company before they can use a specific m-service (e.g. m-banking). Thus, the acceptance of m-services in this study refers to the extent to which a consumer is willing to apply for using a package of cellular phone m-services (e.g. i-Mode) from a telecommunication company in order to conduct specific mobile transactions. The intent is to develop a generic model for m-service acceptance and provide important implications for telecommunication companies that market a group of m-services. An m-service adopter may not use all of the m-services provided by a telecommunication company. However, the definition of the m-service acceptance used herein reflects the characteristics of the m-service context in Taiwan, and allows us to develop a generic model for predicting consumer intentions to initially accept a set of m-services (overall m-services), not just a specific m-service.

Based on the theory of planned behaviour (TPB) and the extended technology acceptance models (TAMs) developed previously (e.g. Mathieson *et al*., 2001; Gefen *et al*., 2003; Wang *et al*., 2003), Luarn & Lin (2005) propose an integrated model to explain why individuals voluntarily accept or reject m-banking service. However, whether their m-banking acceptance model can be generalized to investigating 'overall' m-service acceptance has not been addressed. As Berthon *et al*. (2002) suggest, although much attention has been paid to methodological rigor and pluralism in management information system (MIS) research, replication or replication with extension has received less attention; thus, it is of importance to discover whether theories or models that predict well in one context will be as effective in another, and whether methods that work in one environment will be as well applied in another. Following a context extension strategy suggested by Berthon *et al*. (2002), the main purpose of this study is to respecify and validate the Luarn & Lin's (2005) model, and to see if it can be generalized to predicting consumer intention of using m-service. We will do so by adding one trust-related construct ('perceived credibility') and two resource-related constructs ('self-efficacy' and 'perceived financial resources') to the TAM and re-examining the relationships between the proposed constructs in the m-service context. The findings of this research not only help m-service practitioners develop better user-accepted m-service systems, and promote the new information technology (IT) to potential customers, but also provide insights into the research on m-service acceptance.

THEORETICAL BACKGROUND

M-service acceptance is of particular interest to this current study, and represents a fundamental managerial challenge in m-commerce implementation. A review of prior studies suggests the theoretical foundations of the hypotheses formulations. The TAM and the TPB are the

most used theoretical frameworks in addressing why users accept or reject IT (Legris *et al*., 2003). Prior studies found that TAM appeared to be superior to TPB in explaining behavioural intention to use an IS, and that the decomposed TPB model, which integrates TPB and TAM, is better than TAM (Chau & Hu, 2001; 2002). Pedersen & Ling (2003) also suggests that the traditional adoption models in IS research, such as TAM or TPB, may be modified and extended when they are applied to study the adoption of mobile internet services. It is in this vein that this study reviews two prevalent theories (i.e. TAM and TPB) and Luarn & Lin's (2005) integrated m-banking acceptance model for investigating individual IS acceptance in the context of m-service.

Technology acceptance model

The TAM (Davis, 1989; Davis *et al*., 1989) adapted from the theory of reasoned action (TRA) (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980), posits that user adoption of a new IS is determined by the users' intention to use the system, which in turn is determined by the users' beliefs about the system. TAM further suggests that two beliefs – perceived usefulness and perceived ease of use – are instrumental in explaining the variance in the intention of users. Perceived usefulness is defined as the extent to which a person believes that using a particular system will enhance his or her job performance, and perceived ease of use is defined as the extent to which a person believes that using a particular system will be free of effort. Among the beliefs, perceived ease of use is hypothesized to be a predictor of perceived usefulness.

Information system researchers have investigated and replicated the TAM, and agreed that it is valid in predicting an individual's acceptance of various corporate IT (Adams *et al*., 1992; Segars & Grover, 1993; Chin & Todd, 1995; Doll *et al*., 1998). However, the TAM's fundamental constructs do not fully reflect the specific influences of technological and usage-context factors that may alter user acceptance (Davis *et al*., 1989). Thus, prior studies have extended the TAM with constructs such as perceived playfulness (Moon & Kim, 2001), compatibility (Chen *et al*., 2002), perceived user resources (Mathieson *et al*., 2001), trust (Gefen *et al*., 2003), trustworthiness (Carter & Bélanger, 2005) and perceived credibility (Wang, 2003; Wang *et al*., 2003).

Theory of planned behaviour

The TPB extends from TRA by incorporating an additional construct, namely perceived behaviour control, to account for situations in which an individual lacks substantial control over the targeted behaviour (Ajzen, 1991). According to TPB, an individual's behaviour can be explained by his or her behavioural intention, which is jointly influenced by attitude, subjective norms and perceived behavioural control. Attitude refers to an individual's positive or negative evaluative affect about performing a particular behaviour. Subjective norms refer to an individual's perceptions of other people's opinions on whether or not he or she should perform a particular behaviour, and perceived behavioural control refers to an individual's perceptions of the presence or absence of requisite resources, or opportunities necessary for performing a behaviour (Ajzen & Madden, 1986).

Some researchers have noted that TAM omits variables that may be important predictors of IT/IS usage (Mathieson *et al*., 2001). TPB includes constructs that do not appear in TAM. Mathieson (1991) and Taylor & Todd (1995a) suggest that subjective norms and perceived behavioural control overlap only minimally with TAM's constructs. However, TPB is not specific to IS usage and is less parsimonious than TAM. Also, TPB requires unique operationalizations in every different situation in which it is used (Mathieson *et al*., 2001). In order to retain the underlying simplicity of TAM while improving its ability to explain IS usage, Mathieson *et al*. (2001) incorporated a single construct, 'perceived resources', to TAM, based, in part, on Ajzen's TPB, but operationally consistent with TAM's other constructs, to account for the IS usage. Perceived resource is the extent to which an individual believes that he or she has the personal and organizational resources needed to use an IS, such as skills, hardware, software, money, documentation, data, human assistance and time (Mathieson *et al*., 2001). Mathieson *et al*. (2001) also found that data, documentation and someone's help have no significant effects on the formation of overall perceived resources, implying that some resources are not significant determinants of user acceptance of IS.

Luarn & Lin's m-banking acceptance model

Based on literature relating to the TPB and the extended TAMs (e.g. Mathieson *et al*., 2001; Gefen *et al*., 2003; Wang *et al*., 2003), Luarn & Lin (2005) extends the applicability of the TAM in a m-banking context by adding one trust-based construct ('perceived credibility') and two resource-based constructs ('perceived self-efficacy' and 'perceived financial cost') to the model, with careful attention being given to placing these constructs in TAM's existing nomological structure. Compared with prior studies integrating the TAM and TPB, Luarn & Lin's (2005) m-banking acceptance model has a higher ability to predict and explain behavioural intention to use an IS. However, whether their m-banking acceptance model can be generalized to investigating overall m-service acceptance has not been addressed. In addition, some relationships between the constructs within the Luarn and Lin's model may be omitted. Responding to Berthon *et al*.'s (2002) call for replication and extension research, this study respecifies and validates the Luarn & Lin's (2005) model to see if it can be generalized to predicting and explaining consumer intention to use m-service.

RESEARCH MODEL AND HYPOTHESES

Previous research has suggested that *trust-related* constructs and *resource-related* (*behavioural control*) constructs should be the critical antecedents of the behavioural intention to use IS. Integrating these perspectives and empirically examining the factors that build usage intention in an m-service context that lacks typical human interaction, can advance our understanding of these constructs and their link to m-service adoption behaviour. Based on the IS acceptance literature, especially Luarn & Lin (2005), we propose the research model, as indicated in Figure 1. The construct of perceived financial cost in the Luarn & Lin's (2005) model

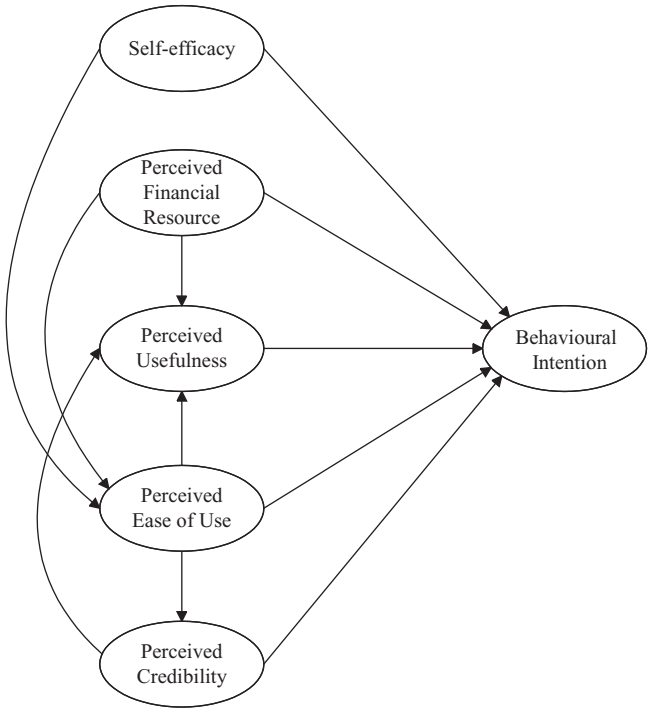

Figure 1. Research model.

is changed to 'perceived financial resource' to be consistent with the nature of the perceived user resource construct proposed by Mathieson *et al*. (2001). Also, some of the construct relationships (e.g. the link from perceived credibility to perceived usefulness) absent in the Luarn & Lin's (2005) model are proposed. The proposed constructs and hypotheses are all supported by prior studies in the IS literature.

Perceived usefulness

There is extensive research in the IS community that provides evidence of the significant effect of perceived usefulness on usage intention (Davis *et al*., 1989; Venkatesh & Davis, 1996; 2000; Jackson *et al*., 1997; Agarwal & Prasad, 1999; Hu *et al*., 1999; Venkatesh, 1999; 2000; Venkatesh & Morris, 2000). The ultimate reason that people exploit m-service systems is that they find the systems useful to their transactions. Therefore, this study tests the following hypothesis:

H1: Higher perceived usefulness will lead to higher behavioural intention to use m-service.

Perceived ease of use

Extensive research over the past decade provides evidence of the significant effect of perceived ease of use on usage intention, either directly or indirectly through its effect on per-

ceived usefulness (Davis *et al*., 1989; Venkatesh & Davis, 1996; 2000; Jackson *et al*., 1997; Agarwal & Prasad, 1999; Hu *et al*., 1999; Venkatesh, 1999; 2000; Venkatesh & Morris, 2000). In order to prevent the 'underused' useful system problem, m-service systems need to be both easy to learn and easy to use.

On the other hand, in a web environment, where the main interaction consumers have with the electronic vendor is through the web site, an easy-to-use web site should lead to the creation of trust (Gefen *et al*., 2003). Moreover, well-explained and easy-to-understand processes are a recipe for creating trust in business transactions (Kumar, 1996). If more effort is placed in configuring the web site so that it is easy-to-use and navigable, users will conclude that the m-service provider has invested in the creation of security and privacy protection. ITs that are easy to use will be less threatening to an individual (Moon & Kim, 2001), implying that perceived ease of use is expected to have a positive influence on users' perception of credibility in their interaction with the online service systems (Wang *et al*., 2003). That is, a consumer that perceives higher ease of use may develop a higher credibility perception towards IS. Perceived ease of use was also found to be a significant antecedent of the trust-related construct. (Gefen *et al*., 2003; Wang, 2003; Wang *et al*., 2003; Luarn & Lin, 2005). Thus, the following hypotheses will be tested:

H2: Higher perceived ease of use will lead to higher perceived usefulness of m-service.
H3: Higher perceived ease of use will lead to higher perceived credibility of m-service.
H4: Higher perceived ease of use will lead to higher behavioural intention to use m-service.

Perceived credibility

Prior studies have suggested that trust is a significant antecedent of participation in online commerce because of the greater ease with which vendors can behave in an opportunistic manner (Reichheld & Schefter, 2000; Gefen *et al*., 2003). Carter & Bélanger (2005) found trustworthiness is a significant predictor of citizens' intention to use an e-government service. Trust has also been shown by many researchers to be an important factor in the success of inter-organizational systems (Ibbott & O'Keefe, 2004) or internet-based electronic markets (Bunduchi, 2005).

Besides the ease of use and usefulness beliefs in TAM, the usage intention of m-service can be affected by perceived credibility. Based on Wang *et al*. (2003), perceived credibility is defined as the extent to which a person believes that using m-service will be free of security and privacy threats. Perceived credibility was also found to have a significant positive influence on the behavioural intentions to use online banking (Wang *et al*., 2003), electronic tax filing (Wang, 2003), electronic learning (Ong *et al*., 2004) and m-banking (Luarn & Lin, 2005). In general, the perceived credibility that people have in the ability of the m-service system to conclude their transactions securely and to maintain the privacy of their personal information, affects their voluntary acceptance of m-service.

On the other hand, perceived credibility should also increase certain aspects of the perceived usefulness of an m-service system. Based on Gefen *et al*.'s (2003) arguments, per-

ceived usefulness of a system depends on the effectiveness of its relevant technological and non-technological properties, such as advanced security and privacy protection. Trust was also found to have a significant effect on perceived usefulness (Gefen *et al*., 2003). Thus, perceived credibility can be an antecedent of perceived usefulness of m-service. This study therefore tests the following hypotheses:

H5: Higher perceived credibility will lead to higher behavioural intention to use m-service.
H6: Higher perceived credibility will lead to higher perceived usefulness of m-service.

Self-efficacy

Previous research on computer self-efficacy (Agarwal *et al*., 2000; Johnson & Marakas, 2000; Chau, 2001; Hong *et al*., 2001) has confirmed the critical role that computer self-efficacy plays in understanding individual responses to IT. Self-efficacy in this study is defined as the judgement of one's ability to use m-service. The proposed relationship between self-efficacy and perceived ease of use is based on the theoretical argument by Davis (1989) and Mathieson (1991). An individual with high expertise might rate a system as easier to use than an individual with lower expertise (Mathieson *et al*., 2001). There also exists empirical evidence of a causal link between self-efficacy and perceived ease of use (e.g. Igbaria & Iivari, 1995; Venkatesh & Davis, 1996; Agarwal *et al*., 2000; Venkatesh, 2000; Wang, 2003).

At the same time, an individual with high expertise might have a higher intention to use a system than an individual with lower expertise. Based on the social cognitive theory, self-efficacy is the belief that one has the ability to perform a specific behaviour (Compeau & Higgins, 1995). Self-efficacy was also found to have a direct influence on system usage (Compeau & Higgins, 1995; Compeau *et al*., 1999). Based on the TPB's perceived behavioural control, Mathieson *et al*. (2001) found that perceived knowledge resources have a significant positive influence on behavioural intention to use an IS in their extended TAM model. This indicates that self-efficacy can be a significant antecedent of the behavioural intention to use m-services with the presence of perceived ease of use in the model. Therefore, this study tests the following hypotheses:

H7: Higher self-efficacy will lead to higher perceived ease of use of m-service.
H8: Higher self-efficacy will lead to higher behavioural intention to use m-service.

Perceived financial resources

Mathieson *et al*. (2001) found that hardware/software and money resources are important for users in adopting an IS. Perceived financial cost has also been found to have a significant negative influence on behavioural intention to use m-banking (Luarn & Lin, 2005). Given that the cost of accessing mobile and wireless service is higher than that of accessing wire-based internet service, this study suggests that financial considerations, including cost of handset, subscription, service and communication fees, might influence consumer behavioural intentions to use m-service. The practicality of this study would have been diminished had we omitted the

influence of financial considerations. Perceived financial resource is defined as the extent to which a person believes that he or she has the financial resources (e.g. to pay for handset, communication time, subscription and/or service) needed to use m-service systems. An individual with high financial resources might have higher perceived ease of use, perceived usefulness and behavioural intention to use m-service than an individual with lower financial resources. Indeed, perceived money (financial) resource was found to have a significant influence on perceived usefulness, perceived ease of use and behavioural intention. (Mathieson *et al*., 2001). Thus, we test the following hypotheses:

H9: Higher perceived financial resources will lead to higher behavioural intention to use m-service.
H10: Higher perceived financial resources will lead to higher perceived usefulness of m-service.
H11: Higher perceived financial resources will lead to higher perceived ease of use of m-service.

RESEARCH DESIGN AND METHOD

Measures of the constructs

Items for the perceived ease of use and perceived usefulness were taken from the previously validated inventory (Davis, 1989; Davis *et al*., 1989) and modified to fit the specific technology studied. The items to measure behavioural intention were taken from previous applications of TAM (Venkatesh & Davis, 1996; Agarwal & Prasad, 1999). The items for the self-efficacy construct were adapted from the original instrument of computer self-efficacy developed by Compeau & Higgins (1995). Perceived credibility was measured by two items adapted from Wang *et al*. (2003) to reflect specific user beliefs concerning the security and privacy protection of m-service. Finally, perceived financial resources were measured by two statements partly adapted from Mathieson *et al*. (2001). Likert scales (1–7), with anchors ranging from 'strongly disagree' to 'strongly agree' were used for all questions, with the exception of those items for measuring self-efficacy whose anchors ranged from 'not at all confident' to 'totally confident'. Pre-testing of the measures was conducted by consumers selected from the m-service field as well as from experts in the area of m-service research. The items were modified to make them relevant to the m-service context. The Appendix 1 lists the items used in this study.

Data collection procedure

The questionnaire consists of an introduction of the m-service transactions and acceptance defined in this study, measures of the constructs (see Appendix 1) and a request for demographic information. As noted earlier, consumers in Taiwan need to join an m-service group supported by a telecommunication company before they can use a specific m-service (e.g.

book travel tickets). Thus, the definition of the acceptance of m-services in the questionnaire refers to the extent to which a consumer is willing to apply for using a package of cellular phone m-services (e.g. i-Mode) from a telecommunication company in order to conduct specific mobile transactions, such as send/receive emails, listen to/download music, download graphics/animation, mobile shopping, read/receive news, play online games, stock trading, book travel tickets, mobile fortune-telling, friend finding, buy books, take part in internet auctions and m-banking. This definition allowed us to develop a generic model for predicting consumer intention to initially join in an m-service group and accept a set of m-services (overall m-services), not just a specific m-service.

Data used to test the research model were gathered from a sample of respondents attending an e-commerce exposition and symposium held in Taiwan. Respondents were asked to participate in a survey. The willing respondents were first introduced to the meanings of m-service transactions and m-services acceptance defined in this study. This declaration made respondents exactly understand that the terms 'transactions' and 'm-services' in the questionnaire refer to overall concepts, not a specific transaction or m-service. Respondents then self-administered the questionnaire and were asked to circle the response which best described their level of agreement with the statements. A total of 573 approaches were made, and 258 completed surveys were obtained. Reason for non-participation was mainly due to a lack of time to complete the survey. Sixty-three per cent of the completed surveys were from male respondents. Respondents of the completed surveys ranged from 18 to 45 years of age (mean = 32 years); 35% had completed one college or university degree; and a further 3% had completed a postgraduate degree.

DATA ANALYSIS AND RESULTS

Measurement model

A confirmatory factor analysis using LISREL 8.3 was conducted to test the measurement model. Nine common model-fit measures were used to assess the model's overall goodness of fit: the ratio of χ^2 to degrees of freedom (d.f.), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), normalized fit index (NFI), non-normalized fit index (NNFI), comparative fit index (CFI), root mean square residual (RMSR), standardized root mean square residual (SRMSR) and root mean square error of approximation (RMSEA). As shown in Table 1, all the model-fit indices exceeded their respective common acceptance levels suggested by previous research, thus demonstrating that the measurement model exhibited a fairly good fit with the data collected. Therefore, we could proceed to evaluate the psychometric properties of the measurement model in terms of reliability, convergent validity and discriminant validity.

Reliability and convergent validity of the factors were estimated by composite reliability[1] and average variance extracted (see Table 2). The interpretation of the composite reliability is sim-

[1]Composite reliability = $(\Sigma \text{ standardized loading})^2/[(\Sigma \text{ standardized loading})^2 + \Sigma\varepsilon_j]$ where the standardized loadings are obtained directly from the program output, and ε_j is the measurement error for each indicator.

Table 1. Fit indices for measurement and structural models

Fit indices	Recommended value	Measurement model	Structural model
χ^2/d.f.	≤3.00	1.49	1.80
GFI	≥0.90	0.95	0.93
AGFI	≥0.80	0.91	0.90
NFI	≥0.90	0.94	0.92
NNFI	≥0.90	0.97	0.95
CFI	≥0.90	0.98	0.96
RMSR	≤0.10	0.034	0.072
SRMSR	≤0.10	0.034	0.072
RMSEA	≤0.08	0.044	0.056

Table 2. Reliability, average variance extracted and discriminant validity

Factor	CR	1	2	3	4	5	6
1. Perceived usefulness (PU)	0.89	0.72					
2. Perceived ease of use (PEU)	0.81	0.13	0.59				
3. Perceived credibility (PC)	0.73	0.14	0.08	0.57			
4. Self-efficacy (SE)	0.83	0.12	0.21	0.02	0.63		
5. Perceived financial resources (PFR)	0.75	0.11	0.02	0.18	0.00	0.60	
6. Behavioural intention (BI)	0.86	0.49	0.28	0.32	0.20	0.25	0.76

Diagonal elements are the average variance extracted. Off-diagonal elements are the shared variance.
CR, composite reliability.

ilar to that of Cronbach's alpha, except that it also takes into account the actual factor loadings rather than assuming that each item is equally weighted in the composite load determination.

Composite reliability for all the factors in our measurement model was above 0.70. The average extracted variances were all above the recommended 0.50 level (Hair *et al*., 1992), which meant that more than one-half of the variances observed in the items were accounted for by their hypothesized factors. Convergent validity can also be evaluated by examining the factor loadings and squared multiple correlations from the confirmatory factor analysis (see Table 3). Following Hair *et al*.'s (1992) recommendation, factor loadings greater than 0.50 were considered very significant. All of the factor loadings of the items in the research model were greater than 0.70. Also, squared multiple correlations between the individual items and their *a priori* factors were high (above 0.50 in all cases). Accordingly, all factors in the measurement model had adequate reliability and convergent validity.

To examine discriminant validity, we compared the shared variances between factors with the average variance extracted of the individual factors (Fornell & Larcker, 1981). This analysis shows that the shared variance between factors were lower than the average variance extracted of the individual factors, which confirms discriminant validity (see Table 2). In summary, the measurement model demonstrated adequate reliability, convergent validity and discriminant validity.

Table 3. Descriptive statistics of items

	Factor loadings	Squared multiple correlations
Perceived usefulness		
PU1	0.86	0.74
PU2	0.82	0.67
PU3	0.87	0.76
Perceived ease of use		
PEU1	0.72	0.52
PEU2	0.78	0.60
PEU3	0.80	0.64
Perceived credibility		
PC1	0.79	0.62
PC2	0.72	0.52
Self-efficacy		
SE1	0.80	0.64
SE2	0.85	0.73
SE3	0.72	0.52
Perceived financial resources		
PFR1	0.82	0.67
PFR2	0.72	0.52
Behavioural intention		
BI1	0.88	0.78
BI2	0.86	0.74

Structural model

A similar set of fit indices were used to examine the structural model (see Table 1). A comparison of all fit indices with their corresponding recommended values provided evidence of a good model fit. Thus, we could proceed to examine the path coefficients of the structural model.

Properties of the causal paths, including standardized path coefficients, *t*-values and variance explained, for each equation in the hypothesized model, are presented in Figure 2. As expected, hypotheses H1, H4, H5, H8 and H9 were supported in that perceived usefulness, perceived ease of use, perceived credibility, self-efficacy and perceived financial resources all had a significant effect on behavioural intention. Altogether, they accounted for 69% of the variance in behavioural intention with perceived usefulness ($\beta = 0.41$) contributing more to intention than perceived ease of use ($\beta = 0.20$), perceived credibility ($\beta = 0.27$), self-efficacy ($\gamma = 0.18$) and perceived financial resources ($\gamma = 0.26$). In addition, hypotheses H2, H3 and H7 were also supported. Self-efficacy was found to have a significant influence on perceived ease of use ($\gamma = 0.47$), which, in turn, had a positive effect on both perceived usefulness ($\beta = 0.29$) and perceived credibility ($\beta = 0.30$). Both perceived financial resource and perceived credibility had a significant effect on perceived usefulness ($\gamma = 0.21$ and $\beta = 0.23$, respectively). Thus, H6

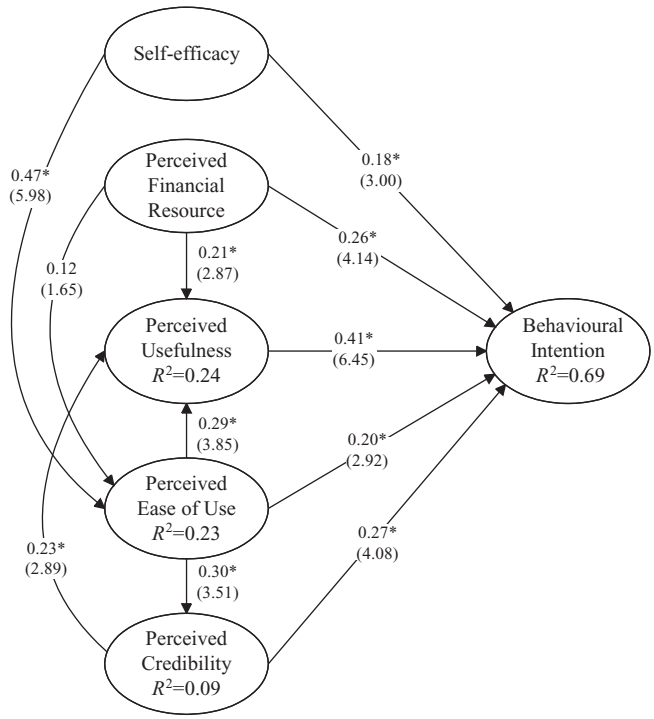

Figure 2. Hypotheses testing results. *$P < 0.05$; *t*-values in parentheses.

and H10 were supported. It is worth noting that the effect of perceived financial resource on perceived ease of use was not significant ($\gamma = 0.12$), with a *t*-value of 1.65. H11 was not supported.

IMPLICATIONS FOR RESEARCH

Prior studies have found that TAM appears to be superior to TPB in explaining behavioural intention of using an IS, and that the decomposed TPB model, which integrates TPB and TAM, is better than TAM but the difference is not substantial (Chau & Hu, 2001; 2002). For example, Taylor & Todd's (1995a) decomposed TPB model explained 60% of the variance in behavioural intention, and their TAM explained 52%, representing only a modest decrease. Consequently, the decomposed TPB's small increase in predictive power comes at the cost of a large increase in model complexity (Mathieson *et al.*, 2001). Compared with prior studies integrating TAM and TPB, the findings of this study strongly suggest that our model with only five independent constructs has a higher ability to predict and explain the behavioural intention of users to use an IS. The variance in intention explained (R^2) in our study was 69%; in the studies of Chau & Hu

(2001), Chau & Hu (2002), Taylor & Todd (1995a) and Mathieson *et al*. (2001), they were 42%, 43%, 60% and 43.8%, respectively.

Therefore, the contributions of this study to IT/IS acceptance research are sixfold. First, it has successfully validated the Luarn & Lin's (2005) m-banking acceptance model, and generalized its application to generic m-service context. Like Luarn and Lin's model, our proposed model integrates the extended TAM's trust-related construct (i.e. perceived credibility), TPB's perceived behavioural control and Mathieson *et al*.'s (2001) perceived user resources (i.e. self-efficacy and perceived financial resources), while paying careful attention to placing these constructs in TAM's existing nomological structure. Although previous research has suggested that trust-related and resource-related (behavioural control) variables should be the critical factors affecting consumer intentions to use IS (e.g. Mathieson *et al*., 2001; Gefen *et al*., 2003; Wang, 2003; Wang *et al*., 2003; Carter & Bélanger, 2005), these constructs have been examined independently by IS researchers. Luarn & Lin (2005) therefore integrated these perspectives and empirically examined the factors that build usage intention in an m-banking context. However, whether their m-banking acceptance model can be generalized to investigating 'overall' m-service acceptance has not been addressed. Following Berthon *et al*.'s (2002) context extension strategy, the findings of this study strongly support the feasibility of using Luarn and Lin's model to understand the acceptance of m-service by individuals.

Second, this study re-examines and respecifies the Luarn and Lin's model, and tests three additional construct relationships absent in their model (i.e. the links from perceived financial resource to perceived ease of use and perceived usefulness, and the link from perceived credibility to perceived usefulness). Except the link from perceived financial resource to perceived ease of use, the hypothesized relationships between the six constructs in the model were significantly supported by the data.

Third, using chi-square difference tests, R^2 and model-fit measures, we conduct a hierarchical model comparison to see if adding the proposed factors (i.e. perceived credibility, self-efficacy and perceived financial resource) to the TAM makes a significant improvement in the variances explained and model-fit indices. The model comparison results indicate that adding one or more of the proposed constructs (i.e. perceived credibility, self-efficacy and perceived financial resource) into the TAM model (base model) makes a substantially large effect on the increase in the variances explained and model-data fit (see Table 4). There are also significant chi-square differences between the full model and the other simpler competing models as shown in Table 4, indicating that our proposed full model is significantly better than the other simpler models.

Fourth, this study supports prior research which found the significant effect of perceived credibility on behavioural intention to use IT/IS in the context of internet banking (Wang *et al*., 2003), electronic learning (Ong *et al*., 2004), m-banking (Luarn & Lin, 2005) and electronic tax filing (Wang, 2003), and it extends its generalizability to the context of m-service. Consistent with prior research, this study also confirms perceived credibility has a significant effect on perceived usefulness. That is, perceived credibility will increase the perceived usefulness of an m-service system by increasing the benefit of security and privacy protection.

Table 4. Model comparison results

	TAM (base model)	TAM +SE	TAM +PFR	TAM +PC	TAM +SE +PFR	TAM +SE +PC	TAM +PFR +PC	Full model
χ^2	286.32	240.67	228.79	211.96	180.28	166.77	190.04	142.57
df	87	85	84	84	82	82	81	79
$\Delta\chi^2$ (Δdf) from base model		45.65* (2)	57.53* (3)	74.36* (3)	106.04* (5)	119.55* (5)	96.28* (6)	143.75* (8)
$\Delta\chi^2$ (Δdf) from full model	143.75* (8)	98.1* (6)	86.22* (5)	69.39* (5)	37.71* (3)	24.2* (3)	47.47* (2)	
GFI	0.87	0.89	0.89	0.90	0.91	0.92	0.91	0.93
AGFI	0.82	0.84	0.85	0.86	0.87	0.88	0.87	0.90
NFI	0.84	0.87	0.87	0.88	0.90	0.90	0.89	0.92
NNFI	0.86	0.89	0.89	0.89	0.92	0.93	0.91	0.95
CFI	0.88	0.91	0.91	0.92	0.91	0.94	0.93	0.96
RMSR	0.19	0.14	0.17	0.16	0.12	0.10	0.14	0.072
SRMSR	0.19	0.14	0.17	0.16	0.12	0.10	0.14	0.072
RMSEA	0.094	0.084	0.082	0.077	0.068	0.063	0.072	0.056
R^2	0.57	0.58	0.65	0.66	0.67	0.67	0.68	0.69

SE, self-efficacy; PFR, perceived financial resource; PC, perceived credibility.
The competing models are 'nested' within the full model.
*$P < 0.01$.

Fifth, this study supports the previous augmented TAM model with perceived resource or perceived behavioural control, and identifies specific resources required to use m-service. Mathieson *et al*. (2001) extended TAM by adding a single construct, perceived resource, to account for barriers to people's use of systems. However, they used both reflective and formative measures to measure a general latent variable of perceived resource in different ways. Recall that perceived resource is the extent to which an individual believes that he or she has the resources needed to use an IS, such as skills, hardware, software, money, documentation, data, human assistance and time. The list of resources may not be complete for all contexts, and it seems likely that some resources are less important in some situations than others (Mathieson *et al*., 2001). Following Mathieson *et al*. (2001) and Luarn & Lin (2005), this study emphasizes the role of perceived user resources in m-service usage and identifies exactly what resources individuals believe are critical in using m-service systems. Both self-efficacy and perceived financial resources were found to be significant determinants of the behavioural intention to use IS. This finding is consistent with Mathieson (1991), Taylor & Todd (1995a,b) and Luarn & Lin (2005), who found that perceived behavioural control or perceived resource influences intention to use an IS. The results indicate that an individual's intention to use an m-service system will be affected by his or her perceptions of the availability of the knowledge and the financial resources needed to use the system. In contrast to measures of perceived behavioural control that concentrate on how well individuals perceive they can execute specific

courses of action, this study examines perceptions of adequate resources that can facilitate or inhibit the behavioural intention to use m-service. Thus, measures of self-efficacy and perceived financial resources, used in this study, provide researchers and practitioners with reference instruments for assessing perceived knowledge and financial resources in using m-service, and help them determine which areas represent potential leverage points for increasing behavioural intention to use an m-service system.

Finally, self-efficacy was found to have a significant influence on perceived ease of use, and perceived financial resource was found to be a significant antecedent of perceived usefulness. These findings support prior research, which found the effect of computer self-efficacy on perceived ease of use (Igbaria & Iivari, 1995; Venkatesh & Davis, 1996; Agarwal *et al*., 2000; Venkatesh, 2000; Hong *et al*., 2001) and the influence of perceived resource on perceived usefulness (Mathieson *et al*., 2001). Consequently, perceived ease of use will depend on an individual's expertise, with a novice judging the same m-service system as more difficult to use than an expert. It was also evidenced that an individual with high financial resources will have higher perceived usefulness of m-service than an individual with lower financial resources.

IMPLICATIONS FOR PRACTICE

This study presents and validates a comprehensive model to explain and predict consumer intentions to use m-service systems based on the TAM, TPB and Luarn & Lin's (2005) m-banking acceptance model. The findings of this study strongly support the feasibility of using the proposed model to assist in understanding the acceptance of m-service by individuals. Perceived usefulness, ease of use, credibility, self-efficacy and financial resources were observed to have positive influences on behavioural intentions. Both perceived credibility and perceived financial resources were found to have a stronger effect on behavioural intention than the traditional TAM variable, perceived ease of use. These results provide several important implications for practice.

Most consumers in Taiwan perceive that using wireless m-services is much more expensive than using wire-based e-commerce. Therefore, telecommunication companies need to ease this perception by the consumer of high financial costs associated with using m-service, through promotions and pricing strategies. In order to reduce the financial barrier facing potential consumers, a telecommunication company can attract new customers by enticing them to use one or two popular m-services through special discounts or free-of-charge strategies. Once customers start using and get used to the m-service, they may be inclined to continue using it and begin to adopt other m-services provided by the same company because of habit or switching cost. On the other hand, prior research indicates that those that currently have adopted the internet and transaction-based e-commerce are much more willing to embrace m-commerce than those that have not yet adopted the system (Anckar & D'Incau, 2002). Thus, telecommunication companies can also use market segmentation and positioning strategy to attract targeted customers, who are willing to pay for time-critical and/or location-based m-services, to use their m-service systems.

The results also indicate that security and privacy issues are important concerns for consumers in using m-service. Although a mobile device is less susceptible to attack by malicious code, this does not mean that m-service is more secure than wire-based e-commerce (Turban *et al*., 2004). By their very nature, mobile devices and mobile transactions produce some unique security challenges (Raina & Harsh, 2002), including physical security, transactional issues and post-transaction issues. Many of the processes, procedures and technologies used to secure e-commerce transactions can also be applied in m-service environment because m-service transactions eventually end up on the wired internet (Turban *et al*., 2004). In addition to the development of secure m-service systems, such as establishment of an authentication mechanism, implementation of a public key infrastructure, and provision of online certification services, telecommunication companies need to increase individuals' perception of security and privacy protection of m-service through appropriate education and propaganda strategies.

The usage of m-service is completely voluntary, lacks organizational resource support, and the target user group consists of a large number of people with very diverse backgrounds. Given these facts, the findings of this study suggest that making the system easy to interact with will be crucial for attracting more users to the m-service. With the proliferation of wireless telecommunications, people in Taiwan are familiar with the function and operation of a mobile phone in telephoning. However, mobile phones suffer from some drawbacks compared with wire-based devices. Siau *et al*. (2001) suggest that mobile devices have '(1) small screens and small multifunction key pads; (2) less computational power, limited memory and disk capacity; (3) shorter battery life; (4) complicated text input mechanisms; (5) higher risk of data storage and transaction errors; (6) lower display resolution; (7) less surfability; (8) unfriendly user interfaces; and (9) graphical limitations' (p. 6). These limitations might make it difficult for the consumers to figure out what kinds of m-services are provided or how to use them, because they need more multimedia displays and more complex user operations than the standard mobile telephoning function. Thus, telecommunication companies should cooperate with mobile phone manufacturers to develop easier to use mobile devices, including touch screen menus, hand-writing recognition, natural language processing, etc. As to the software design, telecommunication companies can develop customized user interfaces, such as a one-touch key to make the operation of m-services easier to learn and use for individuals. For example, one of the reasons why Apple iPod is so successful is the ease of use of its hardware and software.

Increasing the perceived usefulness of m-service systems by potential customers is very important for m-service practitioners. As noted earlier, perceived usefulness is defined as the extent to which a person believes that using a particular m-service will enhance his or her job performance. This means that the critical factor affecting consumers' usage intention of m-services is their perception of usefulness of the m-services. M-service providers should take advantage of the value-adding characteristics of m-service in promoting perceived usefulness. For example, mobility can help individuals get timely information, make quick responses or decisions, and increase their competitive advantage in business. Emphasizing the business use of m-service may be more effective in promoting the perceived usefulness than emphasizing the private use of m-service. In addition, m-service practitioners should conduct market research on the needs, wants and demands of their target customers in order to identify the

potential early success m-service applications as well as provide suitable and useful services for them.

As suggested by our proposed model, perceived financial resource, perceived credibility and perceived ease of use influence the behavioural intention, either directly or indirectly through their effect on perceived usefulness. Self-efficacy also influences behavioural intention indirectly through its effect on perceived ease of use. Accordingly, to increase perceived usefulness, perceived ease of use and behavioural intention, it may be worthwhile for management to focus their attention on the 'cultivation' of self-efficacy, perceived financial resource and perceived credibility. In addition to the cost, security and privacy concerns mentioned earlier, it is very important for management to promote people's self-efficacy of m-service. M-service practitioners need to facilitate the creation of wireless information infrastructures and alleviate the digital divide resulting from differences in family income, educational attainment, occupation, employment status, race, gender, age and geography. Furthermore, organizing education and training courses in various mobile computing technologies can facilitate people's familiarity with m-service applications and help them develop positive ease of use beliefs in the m-service systems, which, in turn, influence the perceived usefulness, perceived credibility and behavioural intentions for using these new service systems. The cause of an underused m-service system may be because potential users have not enough knowledge resources required to use the system. An appropriate intervention might very well be an inexpensive education campaign, rather than a system redesign (Mathieson *et al*., 2001).

LIMITATIONS AND FUTURE RESEARCH

It is worth noting that the effects of perceived ease of use and self-efficacy on behavioural intention are marginally significant. These findings may occur as the result of the great popularity of mobile phone usage and the relatively high user-perceived ease of use and self-efficacy towards m-service systems in Taiwan. Especially, the relatively young respondent sample could have contributed to this result because of its 'expertise'. Therefore, a number of limitations and issues remain to be addressed in the future.

First, investigation of m-service acceptance is relatively new to researchers in the field of IS. The findings discussed and their implications were obtained from one single study that examined a particular technology and targeted a specific user group in Taiwan. Thus, this study suffers from problems with geographical size and location of the population. Predicting usage intention of m-service in a small, densely populated geographical area that has unlimited access to an m-service infrastructure varies greatly from a population that is sparely located in rural areas. If future researcher wishes to make glittering generalities, they should first randomize their sample to include other nationalities and geographical areas besides Taiwan. Therefore, continued research is needed to generalize the findings of this study and extend the discussion to include additional technologies or groups.

Second, searching for additional variables that will improve our ability to predict usage intention more accurately is necessary. It would be reasonable to add social norms, perceived play-

fulness and perceived critical mass to our proposed model, further expanding the number of situations to which it applies.

Third, we did not incorporate actual usage behaviour in the proposed model. This is not a serious limitation as there is substantial empirical support for the causal link between intention and behaviour (Taylor & Todd, 1995a; Venkatesh & Davis, 2000; Venkatesh & Morris, 2000). However, behavioural intentions are only partially useful as their correlation with actual behaviour is low and mediated by many other variables. Thus, continued research is needed to discuss this more thoroughly.

Fourth, in order to decrease the length of the questionnaire and increase the willingness of consumers to participate in our survey, we used the simplified measures of self-efficacy, perceived usefulness and perceived ease of use. That is, we only kept three of the 10 original items for self-efficacy, three of the six for perceived usefulness and perceived ease of use, respectively. In addition, we used two items for three constructs, respectively. This may violate the 'three measures rule' for identification (Rigdon, 1995).

Fifth, this study only examined the main effect of drivers on behavioural intentions. However, m-service managers may be interested in how some of these drivers interact to affect adoption intention. For example, would perceived usefulness interact with self-efficacy or perceived financial resources to affect consumer intention? Future research can re-examine the entire conceptual model.

Sixth, the model is cross-sectional, that is, it measures perceptions and intentions at a single point in time. However, perceptions change over time as individuals gain experience (Venkatesh & Davis, 1996; Mathieson *et al*., 2001; Venkatesh *et al*., 2003). This change has implications for researchers and practitioners interested in predicting m-service usage over time. Additional research efforts are needed to evaluate the validity of the investigated model and our findings. A dynamic model or longitudinal evidence would not only help predict beliefs and behaviour over time, but also enhance our understanding of the causality and the interrelationships between variables that are important to the acceptance of m-service by individuals.

Finally, self-efficacy and facilitating conditions have been modelled as indirect determinants of intention fully mediated by perceived ease of use (Venkatesh, 2000). Venkatesh *et al*.'s (2003) model of Unified Theory of Acceptance and Use of Technology (UTAUT) also shows when effort expectancy (perceived ease of use) construct is present in the model, self-efficacy and facilitating conditions become non-significant in predicting intention. However, this study suggests that with the presence of perceived ease of use in the model, self-efficacy and perceived financial resource are still significant determinants of behavioural intention of m-service usage. Because the UTAUT has not been tested in the context of m-service, future research could compare our model with the UTAUT in predicting m-service usage intention.

CONCLUSIONS

Responding to Berthon *et al*.'s (2002) call for replication and extension research, this study, based on the TAM, TPB and Luarn & Lin's (2005) model, respecifies and validates an inte-

grated model for predicting consumer intention to use m-service by adding perceived credibility, self-efficacy and perceived financial resources to the TAM's nomological structure and re-examining the relationships between the proposed constructs. The results support that the Luarn & Lin's (2005) m-banking acceptance model can be generalized to predicting consumer intention of using m-service. The validated model provides a useful framework for managers needing to assess the possibility of success for m-service introductions, and it contributes to their understanding of the determinants of acceptance in order to pro-actively design interventions targeted at populations of consumers that may be less inclined to accept and use m-service systems.

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APPENDIX 1: MEASURING ITEMS USED IN THIS STUDY

Perceived usefulness

PU1	Using mobile services would improve my performance in conducting transactions.
PU2	Using mobile services would make it easier for me to conduct transactions.
PU3	I would find mobile services useful in conducting my transactions.

Perceived ease of use

PEU1	Learning to use mobile services is easy for me.
PEU2	It would be easy for me to become skilful at using mobile services.
PEU3	I would find mobile services easy to use.

Perceived credibility

PC1	Using mobile services would not divulge my personal information.
PC2	I would find mobile services secure in conducting my transactions.

Self-efficacy

I could conduct my transactions using the mobile service system …

PSE1	. . . if I had just the built-in help facility for assistance.
PSE2	. . . if I had seen someone else using it before trying it myself.
PSE3	. . . if someone showed me how to do it first.

Perceived financial resources

PFR1	Financial resource (e.g. to pay for communication time, subscription, and/or service) is not a barrier for me in using mobile services.
PFR2	I have enough financial resources (e.g. to pay for communication time, subscription, and/or service) for using mobile services.

Behavioural intention

BI1	Assuming that I have access to the mobile services, I intend to use them.
BI2	I intend to increase my use of mobile services in the future.

