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Toward an understanding of the behavioral intention to use mobile banking

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Abstract

Although millions of dollars have been spent on building mobile banking systems, reports on mobile banking show that potential users may not be using the systems, despite their availability. Thus, research is needed to identify the factors determining users' acceptance of mobile banking. While there has been considerable research on the technology acceptance model (TAM) that predicts whether individuals will accept and voluntarily use information systems, limitations of the TAM include the omission of an important trust-based construct in the context of electronic/mobile commerce, and the assumption that there are no barriers preventing an individual from using an IS if he or she chooses to do so. Based on literature relating to the theory of planned behavior (TPB) and the TAM, this study extends the applicability of the TAM in a mobile 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, while paying careful attention to the placing of these constructs in the TAM's existing nomological structure. Data collected from 180 users in Taiwan were tested against the extended TAM, using the structural equation modeling approach. The results strongly support the extended TAM in predicting users' intentions to adopt mobile banking. Several implications for IT/IS acceptance research and mobile banking management practices are discussed.
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1. Introduction

Traditional, branch-based retail banking remains the most widespread method of conducting banking transactions in Taiwan and other countries. However, mobile and wireless technology is rapidly changing the way personal financial services are designed and delivered. For several years, commercial banks in Taiwan have tried to introduce mobile banking systems to improve their operations and reduce costs. Despite all the efforts aimed at developing better and easier mobile banking systems, these systems can easily remain unnoticed by customers, or are seriously under-used despite their availability. In 2003 in Taiwan, according to statistics from the Directorate-General of Budget, Accounting & Statistics (DGBAS) in the Taiwanese government, there were 24.5 million subscriptions to mobile phones, which translates into 106.5 subscriptions for every 100 people. However, less than 1% of banking transactions in Taiwan were conducted through mobile handsets. Mobile banking services are still in their infancy, leaving a great deal of room for development. There is a need, therefore, to understand users' acceptance of mobile banking and to identify the factors affecting their intentions to use mobile banking. This information can assist developers in the building of mobile banking systems that consumers want to use, or help them discover why potential users avoid using the existing system.

The technology acceptance model (TAM) (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989) has received significant attention in IT/IS acceptance literature. According to the TAM, system usage behavior is determined by the intention to use a particular system, which in turn, is determined by the perceived usefulness and perceived ease of use of the system. While the TAM has many strengths, including its specific focus on IS use, its basis in social psychology theory, the validity and reliability of its instruments and its parsimony, one of its limitations is the assumption that its use is volitional; in other words, there are no barriers to prevent an individual from using an IS if he or she chose to do so (Mathieson, Peacock, & Chin, 2001). There may be situations in which an individual wants to use an IT, but is prevented by lack of time, money or expertise (Mathieson, 1991; Mathieson et al., 2001; Taylor & Todd, 1995a, 1995b; Chau & Hu, 2001). Since mobile commerce technology is relatively new, many people may choose not to use the wireless/mobile banking service due to cost considerations or because they lack the required knowledge, skills, or ability to use the new IT. Consequently, in this research, two new constructs, "perceived self-efficacy" and "perceived financial cost", adapted from perceived behavioral control in the theory of planned behavior (TPB) have been introduced to the original TAM. While they are not present in the original TAM, these additional constructs will enable enhanced understanding of an individual's behavior in the acceptance of mobile banking in the context of wireless commerce.

In addition, recent research reveals that the perceived trust or credibility of users, in relation to Web systems, has a striking influence on their willingness to engage in online shopping, banking and the exchange of money and sensitive personal information (Friedman, Kahn, & Howe, 2000; Gefen, Karahanna, & Straub, 2003; Hoffman, Novak, & Peralta, 1999; Wang, Wang, Lin, & Tang, 2003). Most users who refuse to provide sensitive information to mobile banking systems, for the

purpose of banking transactions, report it is because they do not trust those collecting the data. The lack of perceived credibility is manifested in people's concerns that the mobile banking system (and/or the hackers or system intruders) will transfer their personal information or money to third parties, without their knowledge or permission. Hence, the TAM can miss important sources of variances in the mobile banking context. The construct of "perceived credibility", proposed by Wang et al. (2003), has also, therefore, been included in the extended TAM to explore users' acceptance of mobile banking.

The primary objective of this research is to extend the TAM, while retaining its parsimony and IS focus in the context of mobile banking. Based on the literature regarding the TPB and the TAM, this study extends the TAM's applicability to the context of mobile banking, 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 to the placing of these constructs within the TAM's existing nomological structure. An important goal of this work is to develop a model that can provide useful information to mobile banking practitioners, while at the same time maintaining the TAM's theoretical and psychometric rigor. By explaining users' intentions from a user's perspective, the findings of this research can not only help mobile banking authorities develop a more user-accepted mobile banking system, but can also provide insight into the best way to promote new IT systems to potential users.

2. Theoretical background

Of particular interest to the current study is wireless IT/IS acceptance, a fundamental managerial challenge in the implementation of mobile banking. Thus, a review of prior studies suggested the theoretical foundations of the formulations used in our hypotheses. To this end, this study examines two prevalent theories (i.e., TAM and TPB) for investigating individual IT/IS acceptance in a mobile banking context.

2.1. Technology acceptance model

A growing body of academic research is focused on examining the determinants of computer technology acceptance and its utilization (e.g., Davis, 1989; Davis et al., 1989; Mathieson, 1991; Moore & Benbasat, 1991; Taylor & Todd, 1995a). Among the different models that have been proposed, the Technology Acceptance Model (TAM) (Davis, 1989; Davis et al., 1989), adapted from the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975), appears to be the most widely accepted among information systems researchers. The main reason for its popularity is perhaps its parsimony, as well as its wealth of recent empirical support (Agarwal & Prasad, 1999). While the TRA is a general theory of human behavior, the TAM is specific to IS usage (Mathieson et al., 2001). The TAM posits that a user's adoption of a new information system is determined by that user's

intention to use the system, which in turn is determined by the user's beliefs about the system. The TAM further suggests that two beliefs – perceived usefulness and perceived ease of use – are instrumental in explaining the variance in users' intentions. Perceived usefulness is defined as the extent to which a person believes that using a particular system will enhance his or her job performance, while 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 these beliefs, perceived ease of use is hypothesized as a predictor of perceived usefulness.

Information systems researchers have investigated and replicated the TAM, and agreed that it is valid in predicting the individual's acceptance of various corporate IT systems (Adams, Nelson, & Todd, 1992; Chin & Todd, 1995; Doll, Hendrickson, & Deng, 1998; Segars & Grover, 1993). However, the TAM's fundamental constructs do not fully reflect the specific influences of technological and usage-context factors that may alter the users' acceptance (Moon & Kim, 2001). As Davis (1989) noted, future technology acceptance research must address how other variables affect usefulness, ease of use and user acceptance. Therefore, perceived ease of use and perceived usefulness may not fully explain behavioral intentions towards the use of mobile banking, necessitating a search for additional factors that can better predict the acceptance of mobile banking. Prior studies have extended the TAM with constructs such as perceived playfulness (e.g., Moon & Kim, 2001), cognitive absorption (e.g., Agarwal & Karahanna, 2000), and product involvement and perceived enjoyment (Koufaris, 2002). Recently, Gefen et al. (2003) added a "trust" construct to the TAM in an online shopping context. Wang et al. (2003) also successfully introduced a trust-related construct, perceived credibility, as a new TAM factor to reflect the user's security and privacy concerns in the acceptance of online banking. Considering the context similarity between Internet banking and mobile banking, this study extends TAM by adding perceived credibility to the model.

2.2. Theory of planned behavior

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

Other researchers have noted that the TAM omits variables that may be important predictors of IT/IS usage (Mathieson et al., 2001). TPB includes constructs that do not appear in the TAM. Mathieson (1991) and Taylor and Todd (1995a)

suggest that subjective norms and perceived behavioral control overlap only minimally within the TAM's constructs. However, TPB is not specific to IS usage and is less parsimonious than the TAM. Also, TPB requires unique operationalizations in each situation in which it is used (Mathieson et al., 2001). Prior studies found that the TAM appeared to be superior to TPB in explaining behavioral intention to use an IS, and that the decomposed TPB, which integrates the TPB and TAM, is better than the TAM but the difference is not substantial (Chau & Hu, 2001). For example, Taylor and Todd (1995a) added four constructs to explain the effect of perceived behavioral control and their decomposed TPB, including 13 constructs, explained 60% of the variance in behavioral intention, while the TAM, which included 5 constructs, explained 52%, a modest decrease. So the decomposed TPB's small increase in predictive power comes at the cost of a large increase in model complexity.

In order to retain the underlying simplicity of the TAM while improving its ability to explain IS usage, Mathieson et al. (2001) added a single construct, "perceived resources" to the TAM, based, in part, on Ajzen's TPB, but operationally consistent with the TAM's other constructs, to account for IS usage. Perceived resources are 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). While perceived resources are more specific to the behavior of IS usage than perceived behavioral control, perceived resources conceptually overlap with TPB's perceived behavioral control (Mathieson et al., 2001). Operationally, Mathieson et al. used four general items to measure the reflection of perceived resources, and seven specific items (i.e., hardware/software, knowledge, time, financial resources, someone's help, documentation and data) to measure the formation of perceived resources. While their model incorporates two sets of perceived resource measures (reflective and formative) and provides a diagnostic instrument for measuring resource perceptions, this also largely decreases the parsimony of their model. In addition, Mathieson et al. (2001) found that data, documentation and someone's help had no significant effect on formative perceived resources, implying that some resources are not determinants of user acceptance of information systems.

Ajzen and Madden (1986) differentiated between internal and external perceived behavioral control factors. Internal control factors are factors relating to individual disposition and include the amount of information a person has, along with that person's skills, abilities, emotions and compulsions concerning a specific behavior (Ajzen, 1988). The external control factors "determine the extent to which circumstances facilitate or interfere with the performance of the behavior" (Ajzen, 1988, p. 129). Because specificity is critical to the performance of the theory of planned behavior, different behaviors will be influenced by a unique – and perhaps extensive – set of control factors (Flannery & May, 2000). As Sparks, Guthrie, and Shepherd (1997) noted, several researchers tailored measures of perceived behavioral control to the type of behavioral issue under study. Likewise, we develop relevant control factors based on TPB's perceived behavior control and qualitative interviews, conducted with consumers during the pilot stage of the study.

Ajzen (1991, p. 184) indicated that perceived behavioral control "is most compatible with Bandura's (1977, 1982) concept of perceived self-efficacy which 'is concerned with judgments of how well one can execute courses of action required to deal with prospective situations'" (Bandura, 1982, p. 122). Prior research has confirmed the critical role that computer self-efficacy plays in understanding individual acceptance of IT (Agarwal, Sambamurthy, & Stair, 2000; Chau, 2001; Hong, Thong, Wong, & Tam, 2001; Johnson & Marakas, 2000). Thus, perceived self-efficacy of mobile banking will be an important knowledge resource for users to adopt mobile banking. On the other hand, several consumers confirmed, during our qualitative interviews with them, that financial considerations, including a handset (hardware/software) fee, subscription fee, service fee and communication fee, might influence their behavioral intentions to use mobile banking. Mathieson et al. (2001) also found that hardware/software and financial resources are important for users to use an information system. In our opinion, this study's practicality would have been diminished if we had omitted the influence of financial considerations. Consequently, considering the parsimony of the model, and the resources important to the usage of mobile banking, the current study extends the TAM by adding one internal control factor "perceived self-efficacy" and one external control factor "perceived financial cost" to reflect people's concerns about the knowledge and financial resources needed to use mobile banking. By focusing on resources specific to mobile banking usage, researchers can better delineate the factors that managers may have some degree of control over. Measuring perceptions of the availability of specific resources can assist mobile banking practitioners in identifying opportunities for interventions to increase system use.

3. Research model and hypotheses

The research model tested in this study is shown in Fig. 1. In the extended model, like many other studies of the TAM (e.g., Chau, 1996; Hong et al., 2001; Lu & Gustafson, 1994), the "attitudes" construct has been removed for simplification. The proposed constructs and hypotheses are supported by prior studies in information systems literature.

3.1. Perceived self-efficacy

In general, prior research has suggested a positive relationship between experience with computing technology and a variety of outcomes, such as effects concerning computers and computer usage (Agarwal & Prasad, 1999; Harrison & Rainer, 1992; Levin & Gordon, 1989). A related construct, called computer self-efficacy, has been examined in IS literature (e.g., Compeau & Higgins, 1995; Compeau, Higgins, & Huff, 1999). Continuing research efforts on computer self-efficacy can be observed in recent IS studies (Agarwal et al., 2000; Chau, 2001; Hong et al., 2001; Johnson & Marakas, 2000), which confirm the critical role that computer self-efficacy plays in understanding individual response to information technology. Our study has focused
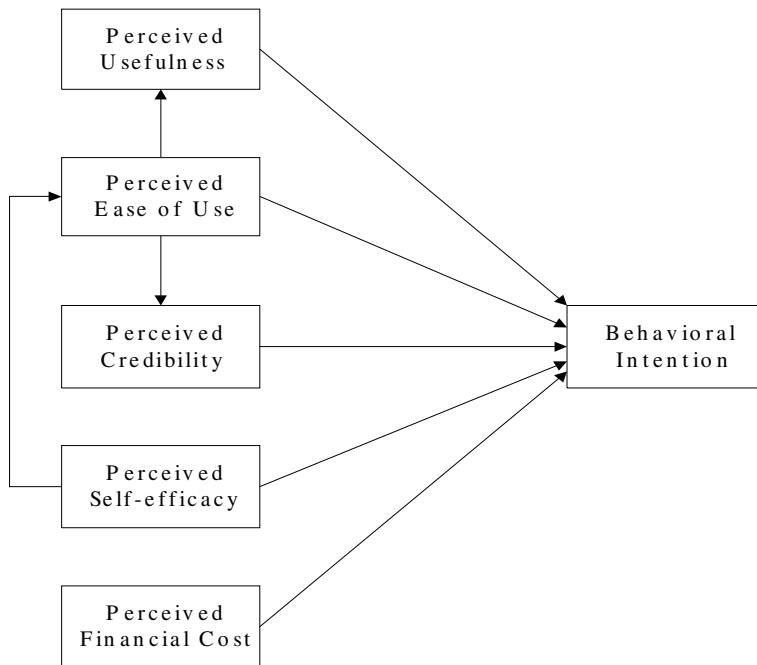
Fig. 1. Research model.

on whether respondents believed they had the required knowledge, skill or ability to use mobile banking. Thus, perceived self-efficacy is defined as the judgment of one's ability to use mobile banking. The proposed relationship between perceived self-efficacy and perceived ease of use is based on the theoretical argument by Davis (1989) and Mathieson (1991). There also exists empirical evidence of a causal link between self-efficacy and perceived ease of use (e.g., Agarwal et al., 2000; Igbaria & Iivari, 1995; Venkatesh, 2000; Venkatesh & Davis, 1996). Based on the theory of planned behavior, Mathieson et al. (2001) found that perceived knowledge resources had a significant positive influence on behavioral intention to use an IS. Therefore, based on the theoretical and empirical support from the IS literature, we tested the following hypotheses:

H1. Perceived self-efficacy will have a positive effect on the perceived ease of use of mobile banking.

H2. Perceived self-efficacy will have a positive effect on behavioral intention to use mobile banking.

3.2. Perceived financial cost

As mentioned earlier, several consumers confirmed, during our qualitative interviews with them, that financial cost considerations might influence their

behavioral intentions to use mobile banking. Perceived financial cost is defined as the extent to which a person believes that using mobile banking will cost money. Indeed, economic motivations and outcomes are most often the focus of IS acceptance studies. Perceived financial resources were also found to be a significant antecedent of the behavioral intention to use an IS (Mathieson et al., 2001), which led us to the following hypothesis:

H3. Perceived financial cost will have a negative effect on behavioral intention to use mobile banking.

3.3. Perceived credibility

Besides the ease of use and usefulness beliefs in the TAM, the usage intention of mobile banking can be affected by the security and privacy concerns of the users. Wang et al. (2003) have conceptually distinguished perceived credibility from perceived risks (e.g., Liao, Shao, Wang, & Chen, 1999) and trust (e.g., Gefen et al., 2003), and found that perceived credibility had a significant positive influence on the behavioral intention to use Internet banking. According to Wang et al. (2003), perceived credibility is defined as the extent to which a person believes that the use of mobile banking will have no security or privacy threats. In general, the perceived credibility that people have in the system, to securely conclude their transactions and maintain the privacy of their personal information, affects their voluntary acceptance of mobile banking. Thus, we tested the following hypothesis:

H4. Perceived credibility will have a positive effect on behavioral intention to use mobile banking.

3.4. Perceived ease of use

Extensive research over the past decade provides evidence of the significant effect perceived ease of use has on usage intention, whether affecting perceived usefulness directly or not (Agarwal & Prasad, 1999; Davis et al., 1989; Hu, Chau, Sheng, & Tam, 1999; Jackson, Chow, & Leitch, 1997; Venkatesh, 1999, 2000; Venkatesh & Davis, 1996, 2000; Venkatesh & Morris, 2000). In order to prevent the "under-used" system problem, mobile banking systems must be both easy to learn and easy to use. Perceived ease of use was also found to be a significant antecedent to the perceived credibility of Internet banking (Wang et al., 2003). Thus, the following hypotheses are proposed:

H5. Perceived ease of use will have a positive effect on the perceived usefulness of mobile banking.

H6. Perceived ease of use will have a positive effect on the perceived credibility of mobile banking.

H7. Perceived ease of use will have a positive effect on the behavioral intention to use mobile banking.

3.5. Perceived usefulness

There is also extensive research in the IS community that provides evidence of the significant effect of perceived usefulness on usage intention (Agarwal & Prasad, 1999; Davis et al., 1989; Hu et al., 1999; Jackson et al., 1997; Venkatesh, 1999, 2000; Venkatesh & Davis, 1996, 2000; Venkatesh & Morris, 2000). The ultimate reason people exploit mobile banking systems is that they find them useful. Therefore, we tested the following hypothesis:

H8. Perceived usefulness will have a positive effect on the behavioral intention to use mobile banking.

4. Research design and method

4.1. Measuring the constructs

To ensure content validity of the scales used, the items selected must represent the concept around which generalizations are to be made. Items selected for the constructs were, therefore, largely adapted from prior studies in order to ensure content validity. The TAM's instruments are psychometrically sound. Perceived ease of use and perceived usefulness instruments show good convergent and discriminant properties (Adams et al., 1992; Chin & Gopal, 1995; Davis, 1989) are internally reliable (Davis, 1989; Davis et al., 1989; Mathieson, 1991) and demonstrate predictive validity (Szajna, 1994). Items for perceived ease of use and perceived usefulness were taken from the previously validated inventory and modified to fit the specific technology studied. The items to measure behavioral intention were taken from previous applications of the TAM (Agarwal & Prasad, 1999; Venkatesh & Davis, 1996). Items for the perceived self-efficacy construct were adapted from the original instrument of computer self-efficacy developed by Compeau and Higgins (1995). Perceived credibility was measured by two items adapted from Wang et al. (2003) to reflect the specific belief of users in the security and privacy protection provided by mobile banking. Finally, perceived financial cost was measured by two statements developed specifically for this study. Likert scales (1–7), with anchors ranging from "strongly disagree" to "strongly agree" were used for all questions, except for the items measuring perceived self-efficacy, which ranged from "not at all confident" to "totally confident." Pre-testing of these measures was conducted through selected consumers from the mobile banking field, as well as experts in the e-commerce research area. The items were modified to make them relevant within the context of mobile banking. The items used in this study are listed in the Appendix A.

4.2. Data collection procedure

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 first asked whether they had ever conducted traditional branch-based banking transactions; if they replied in the affirmative, they were asked to participate in the survey. The screened and qualified respondents conducted a self-administered questionnaire. The questionnaire consisted of the items listed in the Appendix A, with a request for demographic information. Respondents were asked to circle the response which best described their level of agreement with the statements. A total of 394 approaches were made to obtain 180 completed surveys. The reason for nonparticipation was mainly due to a lack of time to complete the survey. Fifty-eight percent of the completed surveys were from male respondents. Respondents ranged from 17 to 48 years of age (mean = 33 years). Forty-three percent had completed one college or university degree; a further 4% had completed post-graduate degrees.

5. Data analysis and results

5.1. Measurement model

A confirmatory factor analysis, using LISREL 8.3, was conducted to test the measurement model. Seven common model-fit measures were used to assess the model's overall goodness-of-fit: the ratio of χ^2 to degrees-of-freedom (df); goodness-of-fit index (GFI); adjusted goodness-of-fit index (AGFI); normalized fit index (NFI); non-normalized fit index (NNFI); comparative fit index (CFI); and root mean square residual (RMSR). 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 proceeded to evaluate the psychometric properties of the measurement model in terms of reliability, convergent validity and discriminant validity.

Table 1
Fit indices for measurement and structural models

Fit Indices	Recommended value	Measurement model	Structural model
χ^2/df	⩽3.00	1.70	1.89
Goodness-of-fit (GFI)	⩾0.90	0.92	0.90
Adjusted goodness-of-fit (AGFI)	⩾0.80	0.87	0.86
Normed fit index (NFI)	⩾0.90	0.94	0.93
Non-normed fit index (NNFI)	⩾0.90	0.96	0.95
Comparative fit index (CFI)	⩾0.90	0.97	0.96
Root mean square residual (RMSR)	⩽0.10	0.041	0.086

Table 2
Reliability, average variance extracted, and discriminant validity

Factor	CR	1	2	3	4	5	6
1. Perceived usefulness	0.91	0.79					
2. Perceived ease of use	0.85	0.44	0.66				
3. Perceived credibility	0.93	0.31	0.30	0.88			
4. Behavioral intention	0.94	0.55	0.59	0.58	0.89		
5. Perceived self-efficacy	0.87	0.13	0.18	0.15	0.29	0.69	
6. Perceived financial cost	0.88	0.02	0.05	0.04	0.16	0.01	0.79

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

Reliability and convergent validity of the factors were estimated by composite reliability and average variance extracted (see Table 2). The composite reliabilities can be calculated as follows: (square of the summation of the factor loadings)/{(square of the summation of the factor loadings) + (summation of error variables)}. The interpretation of the resulting coefficient is similar 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 0.80. The average extracted variances were all above the recommended 0.50 level (Hair, Anderson, Tatham, & Black, 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 to be very significant. All of the factor loadings of the items in the research model were greater than 0.50, with most of them being above 0.80. Also, squared multiple correlations between the individual items and their a priori factors were high (above 0.50 in all cases). Thus, 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 from the individual factors (Fornell and Larcker, 1981). This analysis showed that the shared variance between factors was lower than the average variance extracted from the individual factors, confirming discriminant validity (see Table 2). In summary, the measurement model demonstrated adequate reliability, convergent validity and discriminant validity.

5.2. Structural model

A similar set of fit indices was used to examine the structural model (see Table 1). Comparison of all fit indices with their corresponding recommended values provided evidence of a good model fit ($\chi^2/df = 1.89$, GFI = 0.90, AGFI = 0.86, NFI = 0.93, NNFI = 0.95, CFI = 0.96, RMSR = 0.086). Thus, we proceeded to examine the path coefficients of the structural model.

Table 3
Descriptive statistics of items

	Factor loadings	Squared multiple correlations
Perceived usefulness		
PU1	0.83	0.69
PU2	0.91	0.84
PU3	0.91	0.83
Perceived ease of use		
PEU1	0.83	0.70
PEU2	0.83	0.69
PEU3	0.77	0.60
Perceived credibility		
PC1	0.92	0.85
PC2	0.95	0.91
Perceived self-efficacy		
PSE1	0.83	0.68
PSE2	0.89	0.79
PSE3	0.77	0.59
Perceived financial cost		
PFC1	0.79	0.63
PFC2	0.98	0.96
Behavioral intention		
BI1	0.94	0.88
BI2	0.95	0.90

Properties of the causal paths, including standardized path coefficients, *t* values and explanation of variance for each equation in the hypothesized model are presented in Fig. 2. As expected, hypotheses H2, H3, H4, H7, and H8 were supported in that perceived self-efficacy, perceived financial cost, perceived credibility, perceived ease of use and perceived usefulness all had a significant effect on behavioral intention. Altogether, they accounted for 82% of the variance in behavioral intention with perceived credibility ($\beta = 0.36$) contributing more to intention than contributed by perceived usefulness ($\beta = 0.31$), perceived ease of use ($\beta = 0.33$), perceived self-efficacy ($\beta = 0.18$), and perceived financial cost ($\beta = -0.19$). Hypotheses H1, H5, and H6 were also supported. Perceived self-efficacy was found to have a significant influence on perceived ease of use ($\beta = 0.46$), which in turn had a positive effect on both perceived usefulness ($\beta = 0.69$) and perceived credibility ($\beta = 0.65$). The total effect of perceived self-efficacy on behavioral intention was 0.54 ($= 0.18 + 0.46 * 0.65 * 0.36 + 0.46 * 0.33 + 0.46 * 0.69 * 0.31$).

6. Discussion

Considerable research has been carried out on the TAM, which predicts whether individuals will accept and voluntarily use information systems. The TAM's primary
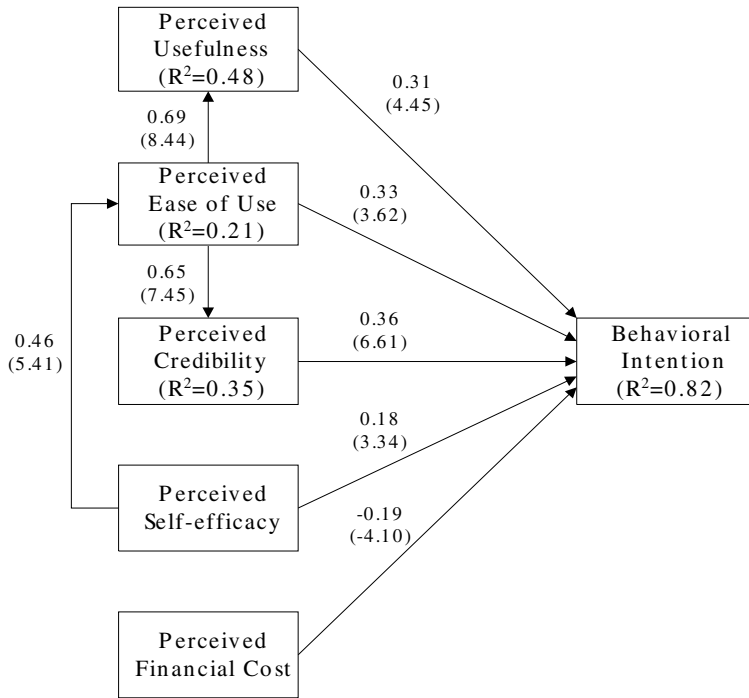
Fig. 2. Hypotheses testing results. *Note. t*-Values for standardized path coefficients are described in parentheses.

exogenous variables are usefulness and ease of use. However, although an individual may believe that a system is useful and easy to use, he or she may think they lack the resources (e.g., money and expertise) required to use it. Recent research also reveals that a user's concerns surrounding the security and privacy protection of an e-commerce system have a significant influence on user acceptance of online shopping and banking. Hence, the TAM can miss important sources of variance in a mobile banking context.

This study has extended the TAM, while retaining its parsimony and IS focus, within the context of mobile banking. Based on the literature relating to the TPB and the TAM, "perceived self-efficacy" and "perceived financial cost" were introduced as new TAM factors to reflect people's concerns about their knowledge and financial resources needed to use mobile banking; the influence of the construct "perceived credibility," proposed by Wang et al. (2003), on the intention to use mobile banking, was also examined. Our findings strongly support the appropriateness of using this extended TAM to understand the intentions of people towards the use of mobile banking services. Significant effects influencing behavioral intention from perceived usefulness, ease of use, credibility, self-efficacy and financial costs were observed. We also found perceived credibility to have a stronger influence on behavioral intention than the traditional TAM variables

(perceived usefulness and perceived ease of use); that is, security and privacy issues were found to be a significant concern for consumers when using mobile banking. It is worth noting that perceived financial cost is also a significant barrier for users of mobile banking. Given that mobile banking use is completely voluntary, lacks organizational resource support, and has a target user group consisting of large numbers of people with greatly diversified backgrounds, the findings of this study suggest that in order to attract more users to mobile banking, it will require more than simply making the system easier to use. It is of paramount importance to develop mobile banking systems with valuable functions and a perceived trustworthiness to protect the security and privacy of the users. In addition, the mobile banking authorities must reduce the users' perceived financial cost through creative promotional and pricing strategies.

On the other hand, perceived self-efficacy was found to have a significant effect on perceived ease of use, which in turn had positive influences on perceived usefulness, perceived credibility and behavioral intention. These findings support prior research, which found that computer self-efficacy influenced perceived ease of use (Agarwal et al., 2000; Hong et al., 2001; Igbaria & Iivari, 1995; Venkatesh, 2000; Venkatesh & Davis, 1996) and that perceived ease of use influenced both perceived usefulness (Davis, 1989; Davis et al., 1989) and perceived credibility (Wang et al., 2003). As suggested by our extended TAM, perceived self-efficacy influences behavioral intention, either directly or indirectly, through its effect on perceived ease of use. Thus, management attention might be more fruitfully focused on the ''development'' of perceived self-efficacy. Mobile banking practitioners can increase their customers' intent to use the system through perceived self-efficacy and the mediating TAM variables (i.e., perceived ease of use, perceived usefulness and perceived credibility). In order to promote a customer's perception of self-efficacy in mobile banking, managers could organize training courses in various mobile commerce applications, thus increasing customers' familiarity with mobile computing technologies. Even if these courses are not directly related to mobile banking, they can still help customers develop positive usefulness, ease of use and credibility beliefs in the system, which in turn can influence behavioral intention to use mobile banking services.

Compared with prior studies integrating the TAM and TPB, the findings of this study strongly suggest that our extended TAM has a higher ability to predict and explain behavioral intention to use an information system. The R-square in our study was 82%; in the studies of Chau and Hu (2001), Taylor and Todd (1995a), Mathieson (1991) and Mathieson et al. (2001), it was 42%, 60%, 70% and 43.8%, respectively. Our model, therefore, represents a large improvement in explanatory power, with only a small increase in model complexity.

7. Conclusions

This study is a pioneering effort in applying the TAM to the newly emerging context of mobile banking, which has recently become available. Limitations of the

TAM include the omission of a trust-based construct in the context of electronic/mobile commerce and the assumption that there are no barriers preventing an individual from using an IS if he or she chooses to do so. Based on the literature regarding the TAM and TPB, this study successfully extends TAM's applicability to the context of mobile banking by adding one trust-based construct ("perceived credibility") and two perceived behavioral control factors ("perceived self-efficacy" and "perceived financial cost") to the model, paying close attention to the placement of these constructs within TAM's existing nomological structure. By explaining usage intention from a user's perspective, the findings of this research can not only assist mobile banking authorities in the development of better user-accepted mobile banking systems, but can also provide insight into how to promote the new IT to potential users.

The contributions of this study to IT/IS acceptance research are fourfold. First, it successfully applied the TAM in a new IS context (i.e., mobile banking), very different from the systems examined in prior studies. Consistent with previous studies, perceived usefulness and perceived ease of use were found to be significant antecedents of the behavioral intention to use mobile banking. Second, this study supports Wang et al.'s (2003) research that found a significant direct relationship between perceived credibility and behavioral intention to use Internet banking, and so extends its generalizability to mobile banking. Third, perceived self-efficacy and perceived financial cost were also found to be significant antecedents of behavioral intention to use mobile banking. In contrast to measures of perceived behavioral control that concentrate on how well individuals perceived their ability to execute specific courses of action, this paper examines perceptions of adequate resources that can facilitate or inhibit behavioral intention to use mobile banking. Measures of perceived self-efficacy and perceived financial cost were developed and tested. These measures not only represent specific instruments that can be used to assess perceived knowledge and financial resources, but can also be used by researchers and practitioners to determine which areas represent potential leverage points to increase behavioral intention to use an information system. Finally, perceived self-efficacy was found to have a significant influence on perceived ease of use, which in turn significantly influenced both perceived usefulness and perceived credibility.

A number of issues remain to be addressed. First, the investigation of mobile banking acceptance is relatively new to IS researchers. The discussed findings and their implications were obtained from one single study that examined a particular technology and targeted a specific user group in Taiwan. Thus, continued research is needed to generalize our findings and discussion to include other technologies or groups. Second, there is a need to search for additional variables that can improve our ability to more accurately predict usage intention. It would be reasonable to add social norms or perceived critical mass to our extended TAM, further expanding the number of situations to which it applies. Third, 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 (Mathieson et al., 2001; Venkatesh & Davis, 1996). This change has implications for researchers and practitioners interested in predicting

mobile banking usage over time. Additional research efforts are needed to evaluate the validity of the investigated models, as well as our findings. A dynamic model or longitudinal evidence would not only help predict beliefs and behavior over time, but also enhance our understanding of the causality and interrelationships between variables, that are important to individuals' acceptance of mobile banking.

Appendix A

Perceived usefulness

PU1   Using mobile banking would improve my performance in conducting banking transactions.

PU2   Using mobile banking would make it easier for me to conduct banking transactions.

PU3   I would find mobile banking useful in conducting my banking transactions.

Perceived ease of use

PEU1   Learning to use mobile banking is easy for me.

PEU2   It would be easy for me to become skillful at using mobile banking.

PEU3   I would find mobile banking easy to use.

Perceived credibility

PC1   Using mobile banking would not divulge my personal information.

PC2   I would find mobile banking secure in conducting my banking transactions.

Perceived self-efficacy

I could conduct my banking transactions using the mobile banking systems...

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 cost

PFC1   It would cost a lot to use mobile banking.

PFC2   There are financial barriers (e.g., having to pay for handset and communication time) to my using mobile banking.

Behavioral intention

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

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