

# THE ACCEPTANCE OF WIRELESS HEALTHCARE FOR INDIVIDUALS

## *An Integrative View*

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**Abstract:** A recent report showed that the adoption rate of mobile healthcare is relatively low. Thus, a study for how healthcare professionals adopt mobile services to support their work is imperative in practice. An integration of TAM and TPB has considered both technological and organizational aspects in a complementary manner. However, while mobile healthcare is considered as an emerging technology with wireless features and often used in a voluntary motive. The service provision for pervasive usage and individual psychological state are critical in determining the system use. Accordingly, perceived service availability and personal innovativeness in IT are the major drivers for the components of TAM and TPB. This study thus proposed such a research framework for integrating these relevant components from a broader perspective. Empirical research is further conducted for examining its practical validity.

## 1 INTRODUCTION

It is only quite recently that a surge of mainstream popularity has motivated researchers to acknowledge the value of mobile healthcare. Hospitals are the places closely related to people's health and medical professionals are responsible for patients' health and life. Medical professionals always carefully concern the risk or uncertainty in using new technologies for helping medical treatments. Hence, medical professionals usually tend to adopt new technologies later until they have been growing more mature and safe in their use. However, wireless technologies can be widely applied in many ways to help medical professionals complete their work safely and efficiently, such as electronic patient record and real-time monitoring system for heart rate variability. This creates a great need and importance for mobile healthcare in the hospitals. However, a recent survey by the Taiwan government in 2007 indicated a quite low adoption rate of mobile healthcare.

As technology acceptance model (TAM) focuses more on technological aspect for its parsimony and high explained power, however, it lacks considering the effects of individual and organizational factors in the adoption process. Theory of planned behavior

(TPB) is indicated with a consideration of these two factors. Moreover, while mobile devices with wireless features are portable for personal use and provide instant supports for medical activities at anytime and from anywhere, the quality of system services, such as real-time service availability, is the major concern for medical professionals to determine the system use. Many studies have indicated the same concern for understanding the adoption of mobile devices, namely perceived service availability (PSA) (DeLone and McLean, 2003; Venkatesh et al., 2003; Hong and Tam, 2006). In addition, while mobile healthcare is an emerging technology for personal use and often used in a voluntary motive, the psychological state of medical personnel specifically plays a critical role in determining the system use. Many researchers have considered the same concern for identifying individual difference in adopting a new technology, namely personal innovativeness (Thong, 1999; Gallivan, 2003; Tayor, 2007). It is defined as personal innovativeness in IT (PIIT) for IT context (Agarwal and Prasad, 1998; Yi et al., 2006).

In sum, while many studies have proposed a unified model primarily based on TAM and TPB for various IS settings (Venkatesh et al., 2003; Wu and

Chen, 2005), we first integrated TAM and TPB in a complementary manner. Moreover, for the importance of PSA and PIIT in the particular mobile healthcare, an enhancement of the unified view with the two antecedents may positively increase the explained power of a proposed model. Furthermore, empirical examination is conducted for examining its practical validity.

## 2 LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Based on the above discussion, Figure 1 provides a pictorial depiction of this research framework. The followings discuss the theoretical bases and development of relevant hypotheses.

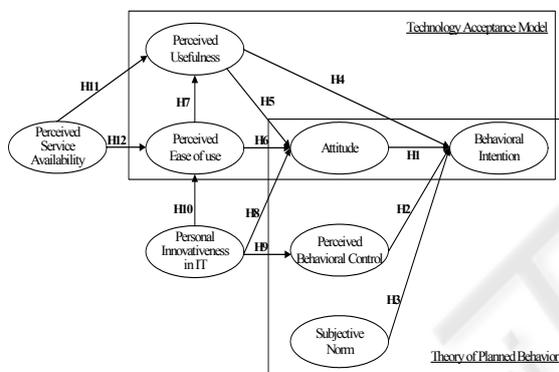


Figure 1: Research model.

### 2.1 Mobile Healthcare

Recent report has shown the importance of health monitoring systems that can reduce the number of readmissions for the patients suffering from many chronic health problems (Toledo et al. in press). The systems can also help in keeping track of patients with one or more cognitive disabilities, such as the stray prevention system for the elderly with dementia (Lin et al. in press). Specifically, examples for mobile healthcare include an implementation of infrared and radio-based locator badges (Stanford, 2002), long-term health monitoring by wearable devices (Jovanov et al. 2002), wireless sensor for blood oxygen saturation monitoring (Asada, et al. 2003). Moreover, the use of wireless technologies can also reduce long-term cost of healthcare and result in an increased productivity of healthcare providers. (Varshney, 2003).

### 2.2 TAM and TPB

TAM is designed for modeling user acceptance of information technology (Davis et al., 1989). This model hypothesizes these relationships, actual use toward certain technology directly influenced by a person's behavioral intention to use (BI) and in turn, behavioral intention to use determined by perceived usefulness (PU) and attitude toward the technology. Furthermore, perceived usefulness and attitude (ATT) are affected by perceived ease of use (PEOU). TPB differs from TAM by adding two components, subjective norm (SN) and perceived behavioral control (PBC). SN refers to the perceived social pressure to perform or not to perform the behavior. PBC refers to people's perception of ease or difficulty in performing the behavior of interest. Consequently, Behavioral intention to use is jointly determined by a person's attitude, subjective norm, and perceived behavioral control toward the behavior.

Some researchers have applied TAM and TPB concepts on the use of telemedicine technologies for healthcare professionals, such as WAP-based telemedicine systems (Chau and Hu, 2002; Yi, et al., 2006). The following discusses the development of relevant hypotheses.

Based on TPB, there are three direct antecedents, attitude, perceived behavioral control, and subjective norm, for determining behavioral intention to use. We can argue that three hypotheses are thus proposed for them.

- H1. Attitude has a positive effect on behavioral intention to use mobile healthcare.
  - H2. Perceived behavioral control has a positive effect on behavioral intention to use mobile healthcare.
  - H3. Subjective norm has a positive effect on behavioral intention to use mobile healthcare.
- Next, according to the TAM structure, as discussed previously, we can argue that four hypotheses are thus proposed for them.
- H4. Perceived usefulness has a positive effect on behavioral intention to use mobile healthcare.
  - H5. Perceived usefulness has a positive effect on attitude toward using mobile healthcare.
  - H6. Perceived ease of use has a positive effect on attitude toward using mobile healthcare.
  - H7. Perceived ease of use has a positive effect on perceived usefulness for mobile healthcare.

### 1.3 PIIT and IT Adoption

Personal Innovativeness represents the degree to which an individual is willing to take a risk by trying out an innovation (Flynn and Goldsmith 1993). Personal innovativeness can be classified into five types: innovators, early adopters, early majority, late majority, and laggards. Personal innovativeness with its application in information technology was first termed personal innovativeness in IT (PIIT) (Agarwal and Prasad, 1998, 1999). The following presents the development of relevant hypotheses. One study analyzed individual's Internet anxiety, an attitude toward the Internet use, when they may experience perceived unreliability, risk, and vulnerability from using it and suggested a relationship between PIIT and the Internet anxiety (Thatcher et al., 2007). Additional study discussed the relationship between software developers' innovativeness and their attitude toward a new development process (Gallivan, 2003). We can posit that one hypothesis is thus proposed for this.

H8. Personal innovativeness in IT has a positive effect on attitude toward using mobile healthcare.

In the study of Yi et al. (2006) in terms of the acceptance of PDA by medical professionals, the PIIT is posited as a direct antecedent of perceived behavioral control toward the behavior of adopting PDA. Another study proposed PIIT as a determinant of computer self-efficacy with respect to the use of Window or Lotus software (Agarwal et al., 2000). Moreover, computer self-efficacy has been indicated as a determinant of perceived behavioral control (Taylor and Todd, 1995). Therefore, the PIIT has the indirect impact on perceived behavioral control toward the behavior. We can argue that one hypothesis is thus proposed for this.

H9. Personal innovativeness in IT has a positive effect on perceived behavior control toward using mobile healthcare.

A prior study indicated that PIIT is a significant antecedent of perceived ease of use in terms of knowledge workers in using IT (Lewis et al., 2003). Another study indicated that higher PIIT leads to higher perceived ease of use for financial service software (Walczuch et al., 2007). We can assume that one hypothesis is thus proposed for this.

H10. Personal innovativeness in IT has a positive effect on perceived ease of use for mobile healthcare.

### 1.4 PSA and IT Adoption

The use of mobile healthcare is closely related to the patients' health and life. Healthcare professionals are usually hesitant to adopt a new system service, such as mobile healthcare, while it is still in the early development stage of its regular use. Among these concerns regarding the mobile service, there is a specific perception that relates to the unique features of this service with wireless devices and its particular usage context for patient safety. Perceived service availability (PSA) refers to the degree to which an innovation is perceived as being able to support pervasive and timely usage. The following discusses the development of relevant hypotheses. Many studies have generally highlighted the importance of service provision in determining the personal use of a new mobile service (Islam and Fayad, 2003; Hong and Tam, 2006). Specifically, one study indicated that PSA is expected to have a direct effect on perceived usefulness of a mobile data service (Hong and Tam, 2006). We can posit that one hypothesis is thus proposed for this.

H11. Perceived service availability has a positive effect on perceived usefulness for mobile healthcare.

The same study, as discussed above, also argued that PSA has the direct influence on perceived ease of use for the mobile data service (Hong and Tam, 2006). The other study proposed that facilitating conditions is a determinant of perceived ease of use for a new technology (Venkatesh, 2000). Facilitating conditions are defined as the provision factors in the user environment to support the use of a new technology (Venkatesh et al., 2003). We can argue that one hypothesis is thus proposed for this.

H12. Perceived service availability has a positive effect on perceived ease of use for mobile healthcare.

## 3 RESEARCH DESIGN

### 3.1 Instrument

#### 3.1.1 Basic Information

This part collects basic information about organizational characteristics including hospital type and bed size as well as respondent characteristics including position, gender, working experience, education level, and age.

**3.1.2 TAM and TPB Constructs**

The measuring items for TAM constructs, including PU, PEOU, ATT, and BI, were adapted from the measurement developed by Venkatesh and Davis (1996; 2000). They contain 4 items, 4 items, 4 items, and 3 items respectively. The measuring items for TPB constructs, including PBC and SN, were adapted from the measurement developed by Taylor and Todd (1995). They contain 3 items and 3 items respectively.

**3.1.3 PIIT and PSA**

The measuring items for PIIT were based on the recommendations of Agarwal and Prasad (1998) and Yi et al. (2006), including 3 items. The measuring items for PSA were adapted from the measurements developed by Venkatesh (2000) and Hong and Tam (2006), including 4 items.

**3.2 Sample Design**

Mobile healthcare is still in an early stage to use and is considered to be a new technology for medical professionals. It was assumed that larger hospitals would be more likely to have this early experience. We randomly selected 80 hospitals to be the study sample from the population of 450 hospitals. Furthermore, physicians and nurses in the hospitals would be the major respondents since they are the major users of mobile healthcare. We first sent an invitation letter to one designated person in each selected hospital and ask them for the help in distributing questionnaires to their colleagues, including physicians and nurses. After that, 10 questionnaires were sent for each hospital through the designated person. A total of 800 questionnaires were sent out to the potential respondents. 140 valid questionnaires were successfully received. The response rate was 17.5%.

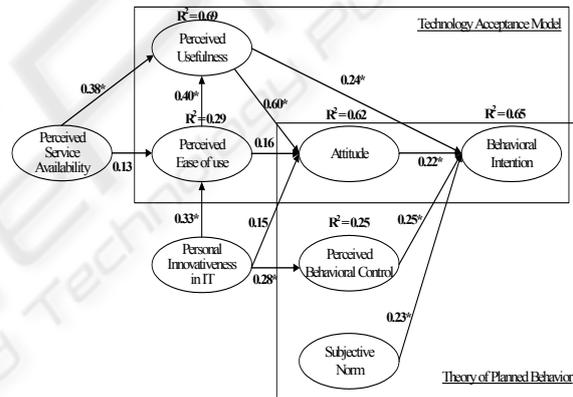
**3.3 Scale Validation**

PLS is a structural equation modeling (SEM) technique that employs a nonparametric and component-based approach for estimation purposes. This study uses PLS to analyze the measurement model. PLS is the best analytical tool available to fit the requirement of small sample size. Convergent validity is assessed by three criteria, factor loading construct reliability, and average variance extracted (Fornell and Larcker, 1981). Discriminant validity is assessed by the measure that AVE for a construct should be larger than the squared correlation between

the construct and other constructs. The testing results indicate that convergent and discriminant validities are all in a high acceptable level.

**4 STATISTICAL ANALYSIS**

PLS was used to examine the structural model. There are two steps in evaluating the structural model. First, we needed to estimate standardized path coefficients and their statistical significance for testing the hypotheses. PLS does not provide a significance test or confidence interval estimation. We re-sampled 1000 times with Bootstrapping analysis to obtain a stable result for these analyses. Second, the coefficient of determination ( $R^2$ ) for endogenous variables was calculated to assess the predictive power of this model. Figure 2 shows the testing results of the structural model.



Value on path: Standardized coefficients ( $\beta$ ),  $R^2$  : Coefficient of determination, \*:  $p < 0.01$

Figure 2: Result of the structure model.

For the components of TPB, attitude, perceived behavior control and subjective norm are all reported to be the important antecedents of behavioral intention to use mobile healthcare ( $\beta=0.22, 0.25, 0.23$ ). Therefore, Hypotheses 1, 2, and 3 are all supported. For the components of TAM, perceived usefulness has a significant positive impact on behavioral intention to use ( $\beta=0.24$ ). Hypothesis 4 is thus supported. Perceived usefulness is a significant determinant of attitude toward using mobile healthcare ( $\beta=0.60$ ). Hypothesis 5 is thus supported. Perceived ease of use reveals no significance in influencing attitude ( $\beta=0.16$ ). Therefore, Hypothesis 6 is not supported. In contrast, perceived ease of use plays a critical role in determining perceived usefulness ( $\beta=0.40$ ). Hypothesis 7 is thus supported.

In a brief summary, the four constructs, attitude, perceived behavioral control and subjective norm, and perceived usefulness, jointly explain 65% variance in behavioral intention to use mobile healthcare ( $R^2=0.65$ ).

For the construct of PIIT, it indicates no significant influence to attitude ( $\beta=0.15$ ). Therefore, Hypothesis 8 is not supported. Conversely, it is the significant determinant of both perceived behavioral control and perceived ease of use ( $\beta=0.28, 0.33$ ). Hypotheses 9 and 10 are thus supported. In a brief summary, the three constructs, perceived usefulness, perceived ease of use, and PIIT, jointly explain 62% variance of attitude toward using mobile healthcare ( $R^2=0.62$ ). Next, PIIT singly explains 25% variance of perceived behavioral control with respect to using mobile healthcare. For the construct of PSA, it indicates as an important antecedent of perceived usefulness ( $\beta=0.38$ ). Hypothesis 11 is thus supported. In contrast, it is not a significant influencer of perceived ease of use ( $\beta=0.13$ ). Therefore, Hypothesis 12 is not supported. In a brief summary, the two constructs, perceived ease of use and PSA, together explain 69% variance of perceived usefulness ( $R^2=0.69$ ). Next, the two unique features for mobile healthcare, PIIT and PSA, jointly explain 29% variance of perceived ease of use ( $R^2=0.29$ ).

## 5 FINDINGS AND DISCUSSIONS

This current model indicates a high explained power for behavioral intention to use mobile healthcare with  $R^2=0.65$  while compared the previous studies. This may be because the four antecedents of behavioral intention to use, that is, perceived usefulness, attitude, perceived behavioral control, and subjective norm, are all significant in their influence. Among these antecedents, perceived usefulness particularly plays the same significant role as the three components of TPB, attitude, perceived behavioral control, and subjective norm. Research on the issue of integrating TAM and TPB has shown mixed results for its impact on behavioral intention to use (Wu and Chen, 2005). Moreover, perceived usefulness has much greater influence on attitude toward using mobile healthcare than perceived ease of use, ( $\beta=0.60$  vs. 0.16). In a brief summary for the two findings, perceived usefulness can be recognized as a particularly important determinant for encouraging the use of mobile healthcare in the hospitals.

Next, this study importantly indicates that PIIT is not

significant in determining attitude, but significant in influencing perceived behavioral control. This finding is particularly new for the adoption of mobile healthcare while attitude is usually reported as the major produced effect in the literature. This finding also explains the above indication for the similar role of perceived behavioral control in affecting behavioral intention to use. More specifically, the reasons to explain this are two-fold. First, while mobile healthcare has been widely advocated and recognized for healthcare professionals in the hospital in order to improve healthcare quality recently, the major problem for determining the use of mobile healthcare is not the favorable or unfavorable trait of healthcare professionals in the psychological state rather than the externally physical forces or control factors to encourage their usage, such as the necessity of using this innovation to treat patients in certain environments. Second, healthcare professionals with high PIIT enforce their interest or psychological state in favor of the use of mobile healthcare and as a result, they perceive better control or ease in performing the adoption behavior.

Finally, PSA, as an important determinant of using new technology, significantly reveals the effect on perceived usefulness and no effect on perceived ease of use. This finding is particularly critical for the use of mobile healthcare while most professionals still thought that mobile healthcare is a type of emerging technology for posing a difficulty to use. This may have an indication for encouraging the professionals to use this technology in the hospitals. The reasons for these results may be noted as below. For the former, mobile healthcare is closely related to the patient life and its usefulness for healthcare professional is greatly dependent on whether it can be regularly operated regardless of the time and places. For the latter, while the design of user interface for mobile services has been in a stable and consistent form for users, PSA may not be an important determinant of perceived ease of use any more at the current technological level.

## 6 CONCLUSIONS AND SUGGESTIONS

The findings have important implications for both practitioners and researchers. For the practitioners, PSA initially drives the forces to determining behavioral intention to use through two layers of mediators in terms of TAM beliefs, that is, perceived usefulness and attitude. This description basically

relates to a particular technological issue in the adoption of mobile services. This means that to effectively encourage medical professionals to use mobile healthcare, the provided service for pervasive and timely usage without any difficulty should be well prepared in the hospitals. Next, the TAM belief (perceived usefulness) and PIIT have indicated to be the underlying antecedents in determining behavioral intention to use through the mediators of attitude and perceived behavioral control respectively. This means that both technological (perceived usefulness) and individual issues (PIIT) are important for overcoming the impediment of using mobile healthcare.

For the technological aspect, the design of mobile healthcare needs to carefully examine the functional requirements of users and further is able to provide useful information for helping the decision making of medical professionals. For the individual aspect, the hospitals may provide incentives for encouraging medical professionals to be often kept in an innovative manner with their regular tasks. This will improve the willingness of an individual to take a risk by trying out an innovation. Finally, the TPB components, attitude, perceived behavioral control, and subjective norm, involve the relevant organizational and individual issues for indicating their impact on the adoption of mobile services. The hospital, as a type of organization's form, should be able to provide some training programs for increasing the skill level of employees and nurturing their confidence in facing new technologies.

For the researchers, prior research on information technology acceptance in general and mobile services in particular has been focused on the general components of TAM or TPB. This research has considered the roles of system services and personal trait in the innovation acceptance. This is because mobile healthcare with wireless features is an emerging technology for medical professionals in terms of high uncertainty in system services, great change of their work styles, and real belief of its usefulness. These considerations are particularly important for the context of mobile healthcare. This will provide a new thinking/concept for theoretically defining the antecedents of behavioral intention to use in the context of mobile healthcare.

Finally, although this research has produced some interesting results, a number of limitations may be inherent in it. Many studies have reported that gender difference plays a moderating role for the relationship between attitude, perceived behavioral control, or subjective norm and behavioral intention to use. Next, the response rate for this survey is lower

than desirable, despite the various efforts to improve it. One of the reasons for this may be due to inexperience of the respondents in using mobile healthcare and reluctant to answer the questionnaire. Finally, while medical doctors from larger hospitals are always quite busy, few questionnaires may have been completed by subordinates and therefore, the data may have some biases.

## REFERENCES

- Agarwal, R. and Prasad, J. (1998). A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information Systems Research*, 9(2), 204–215.
- Agarwal, R. and Prasad, J. (1999). Are individual differences germane to the acceptance of new information technologies? *Decision Sciences*, 30(2), 361–391.
- Agarwal, R. and Karahanna, E. (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS Quarterly*, 24(4), 665–694.
- Asada, H., Shaltis, P., Reisner, A., Rhee, S., and Hutchinson, R. (2003). Mobile monitoring with wearable photoplethysmographic biosensors. *IEEE Engineering in Medical and Biology Magazine*, 28–40.
- Chau, P. Y. K. and Hu, P. J. (2002). Investigating healthcare professionals' decisions to accept telemedicine technology: an empirical test of competing theories. *Information & Management*, 39, 297–311.
- Davis, F. D., Bagozzi, R. P., and Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management Science*, 35, 982–1002.
- DeLone, W.H., and McLean, E.R. (2003). The DeLone and McLean model of information systems success: a ten-year update. *Journal of Management Information Systems*, 19(4), 9–30.
- Flynn, L R. and Goldsmith, R. E. (1993). A validation of the goldsmith and hofacker innovativeness scale. *Educational and Psychological Measurement*, 53, 1105–1116.
- Fornell, C., and Larcker, D.F. Structural equation models with unobservable variables and measurement error: Algebra and statistics. *Journal of Marketing Research*, 18, 3 (1981), 382–388.
- Gallivan, M. J. (2003). The influence of software developers' creative style on their attitudes to and assimilation of a software process innovation. *Information & Management*, 40, 443–465.
- Hong, S.-J. and Tam, K. Y. (2006). Understanding the adoption of multipurpose information appliances: the case of mobile data services. *Information Systems*

- Research*, 17(2), 162-179.
- Islam, N. and Fayad, M. (2003). Toward ubiquitous acceptance of ubiquitous computing. *Communications of ACM*, 46(2), 89-92.
- Jovanov, E., O'Donnell, A., Morgan, A., Priddy, B., and Hormigo, R. (2002). Prolonged telemetric monitoring of heart rate variability using wireless intelligent sensors and a mobile gateway. *The Second Joint IEEE EMBS/BMES Conference*, 1875-1876.
- Lewis, W., Agarwal, R., and Sambamurthy, V. (2003). Sources of influence on beliefs about information technology use: An empirical study of knowledge workers. *MIS Quarterly*, 27(4), 657-678.
- Lin, C., Chiu, M., Hsiao, C., Lee, R., and Tsai, Y. (in press). A wireless healthcare eservice system for elderly with dementia. *IEEE Transactions on IT in Biomedicine*.
- Stanford, V. (2002). Using pervasive computing to deliver elder care. *IEEE Pervasive Computing Magazine*, 10-13.
- Taylor, S. and Todd, P. A. (1995). Understanding information technology usage: A test of competing models. *Information Systems Research*, 6 (2), 144-176.
- Taylor, N. J. (2007). Public grid computing participation: An exploratory study of determinants. *Information & Management*, 44, 12-21.
- Thatcher, J. B., Loughry, M. L., Lim, J., and McKnight, D. H. (2007). Internet anxiety: an empirical study of the effects of personality, beliefs, and social support. *Information & Management*, 44, 353-363.
- Thong, J. Y. L. (1999). An integrated model of information systems adoption in small businesses. *Journal of Management Information Systems*, 15(4), 187-214.
- Toledo, P., Jimenez, S., Pozo, F., Roca, J., Alonso, A., and Hernandez, C. (in press). A telemedicine experience for chronic care in COPD. *IEEE Transactions on IT in Biomedicine*.
- Varshney, U. (2003). Location management for mobile commerce applications in wireless internet. *ACM Transactions on Internet Technologies*, 3(3) 221-232.
- Varshney, U. (2007). Pervasive healthcare and wireless health monitoring. *Mobile Network Applications*, 12, 113-127.
- Venkatesh, V. (2000). Determinants of perceived ease of use: integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information Systems Research*, 11(4), 342-365.
- Venkatesh, V. and Davis, F. (1996). A model of the antecedents of perceived ease of use: development and test. *Decision Sciences*, 27(3), 451-481.
- Venkatesh, V. and Davis, F. (2000). A theoretical extension of the technology acceptance model: four longitudinal field studies. *Management Science*, 46(2), 186-204.
- Venkatesh, V., Morris, M., Davis, G., and Davis, F. (2003). Use acceptance of information technology: toward a unified view. *MIS Quarterly*, 27(3), 425-478.
- Walczuch, R., Lemmink, J., and Streukens, S. (2007). The effect of service employees' technology readiness on technology acceptance. *Information & Management*, 44, 206-215
- Wu, I. L. and Chen, J. L. (2005). An extension of trust and TAM model with TPB in the initial adoption of on-line tax: an empirical study. *International Journal of Human-Computer Studies*, 62, 784-808.
- Yi, M. Y., Jackson, J. D., Park, J. S., and Probst, J. C. (2006). Understanding information technology acceptance by individual professionals: toward an integrative view. *Information & Management*, 43, 350-363.