

Acceptance of Cloud-Based Healthcare Services by Elderly Taiwanese People

Wen-Tsung Ku¹ and Pi-Jung Hsieh²(✉)

¹ Department of General Affairs,
St. Martin De Porres Hospital, Chia-Yi, Taiwan, ROC
kib56265@gmail.com

² Department of Hospital and Health Care Administration,
Chia Nan University of Pharmacy and Science, Tainan, Taiwan, ROC
beerun@seed.net.tw

Abstract. With the increasingly aging population and the advances in information technology (IT), cloud service has become an important health informatics topic. Cloud-based healthcare services have significant potential to enable the elderly to live independently and to access health-care services with ease. Despite this potential, there are gaps in our understanding of how the elderly decide to use such services. A field survey was conducted in Taiwan to collect data from the elderly, and the structural equation model was used to examine the data. The results indicated that attitude, subjective norm, perceived behavioral control, perceived risk, and trust are key determinants in the elderly's usage intentions. The results also indicated that perceived risk and trust integrated with the theory of planned behavior (TPB) model provides an improved method for predicting the elderly's intentions to use cloud-based health-care services. Finally, the implications of this study are discussed.

Keywords: Cloud-based healthcare services · Technology acceptance · Perceived risk · Trust

1 Introduction

Population aging is a pressing problem for many countries, especially for developing countries such as Taiwan. The proportion of the population aged 65 and over was 10.7 % in 2010 and 12 % in 2013, and it is estimated that the elderly population will double to 20 % in only 20 years [1, 2]. In Taiwan, nearly 90 % of people over 65 years of age have one chronic condition, and 50 % have three chronic diseases [3]. Chronic diseases, such as cancer, stroke, respiratory disease, diabetes, and heart diseases, are among the leading causes of death in the country. According to the statistics, nearly 35 % of the total health-care expenditure of the National Health Insurance (NHI) in Taiwan was utilized by elderly people aged 65 and over [4]. As the population ages, more of the elderly are expected to have a greater demand for medical services. To deliver a more comfortable and complete health-care service, cloud-based health services have been proposed to help diagnose, monitor, and provide services to deal with the chronic diseases faced by the elderly in recent years [5, 6].

Cloud-based healthcare services are capable of handling data in the form of text and images, thereby making it possible to maintain complete health databases. This allows health professionals to access health records and make clinical decisions; upload prescriptions; provide healthcare suggestions, including health education and self-health management; and even make emergency calls. Through cloud-based healthcare services, the elderly can obtain healthcare services anytime and anywhere, using mobile devices. These healthcare services have great potential in terms of enabling the elderly to live independently, as well as allowing for the early detection of symptoms and easy access to healthcare services. Hence, many healthcare organizations are looking closely at cloud-based applications for the delivery of healthcare services to the elderly. Despite this potential, there are gaps in our understanding of how the elderly decide to use such cloud-based healthcare services.

Health information technology (IT) use behavior differs in certain ways from typical user behavior with regard to general applications, including the following: (a) health care is not only a type of service but also a lifesaving mechanism, and (b) concerns exist regarding the reliability of the open Internet infrastructure that healthcare service providers employ to interface with users [7]. To elicit the trust of the elderly, cloud-based healthcare service providers must implement more than mere electronic linkages. These differences emphasize the uncertainty of the online environment, the importance of risk, and the significance of new health IT adoption. Thus, the existing variables of the technology acceptance model cannot fully reflect the users and their motives, and, consequently, a study of other intrinsic motivational factors is required. Prior studies have maintained that risk and trust are essential for understanding interpersonal behavior in the field of medical informatics [8, 9]. Based on social psychology theory and the healthcare literature, we have developed an extended version of the theory of planned behavior (TPB) [10] to predict the behavior of the elderly. From a practical standpoint, understanding why the elderly's intention to use the cloud-based healthcare service can help government agencies and healthcare administrators to devise appropriate implementation strategies and cloud-based healthcare services to minimize the elderly's resistance to, and any adverse effects on, the healthcare management system.

2 Background

According to the 2014 Healthcare Information and Management Systems Society Analytics Cloud Survey, 92 % of health-care providers see the value of cloud-based services for their organizations now and in the future [11]. Thus, cloud-based healthcare services has been a critical research topic in the field of medical informatics. Previous studies have investigated the factors influencing IT acceptance by patients through the use of several information technologies, such as remote health monitoring [12], Telecare [13], and mobile health services [14, 15]. Compared with previous studies, we specifically highlight the factors driving the elderly's intention to use cloud-based healthcare services.

2.1 Cloud-Based Healthcare Services

Cloud-based healthcare services enable the elderly to access personalized and interactive health services according to their mobility, portability, and ubiquity. Mobile devices typically include smartphones, personal digital assistants, tablets, notebooks, and health-monitoring devices. Most cloud-based healthcare services use mobile phone platforms. Cloud-based healthcare services have several functions: (a) they improve self-health management and disease diagnosis, treatment, and monitoring; (b) they offer preventive services in health promotion and treatment compliance; and (c) they enhance healthcare processes. For example, the elderly can upload their vital sign data to a cloud platform, via which health professionals can access health records in real time, thus providing a reliable basis for diagnosis. However, for these IT-enabled benefits to materialize, elderly people must first adopt the cloud-based healthcare service. A number of previous studies regarding the health IT adoption behaviors of elderly users developed elderly-specific characteristic constructs to better understand the unique features of the elderly [6, 14, 15]. However, studies that have examined the elderly's willingness to use cloud-based health services are rare.

2.2 Technology Acceptance Theories

Social psychological theories, such as the theory of reasoned action (TRA) [16] and the TPB [10] have been applied to the study of technology acceptance or adoption. TRA is a well-established intention-based theory, according to which behavioral intention is explained by people's attitudes toward that behavior and subjective norms. Although TRA has been evaluated and supported in numerous contexts, it is weak with regard to explaining the essence of behavior. Ajzen [10] found that attitude and subjective norm determine intention and further proposed that perceived behavioral control (PBC) reflects the degree to which a person feels that successfully engaging in a behavior is completely under his or her control. Behavioral intention (BI) measures the strength of the user's willingness to exert effort when performing certain behaviors. Attitude is the individual's general feeling about the desirability or undesirability of a particular behavior. Subjective norm (SN) refers to the individual's perception of important people's opinions about performing or not performing the behavior. PBC reflects a person's perception of the ease or difficulty of performing a specific activity. Ajzen [17] proposed that TPB eliminates TRA limitations on managing behavior over which people have incomplete volitional control. Prior studies have shown that the TPB model has good explanatory power for predicting the health IT acceptance of users [15, 18]. Therefore, this study applies the TPB model to explain the elderly's intention to use cloud-based health services.

2.3 Trust

Trust is one party's confident belief that the other party will behave in a dependable, ethical, and socially appropriate manner [19]. In the cloud-based healthcare context, the elderly are the trustors and the cloud services providers are the trustees because the

elderly provide sensitive information, such as individual identifiers and health records, to the health professionals. The elderly have a limited ability to monitor or control the use of their personal information, which is why trust is required. Under these circumstances, the elderly's concerns about sufficient security for protecting individual data privacy are likely to slow the diffusion of such IT cloud-based healthcare services. Our literature review revealed that further research is necessary to clarify the role of trust perceptions in user acceptance of health IT [8, 9]. This study uses measures of trust to address the elderly's perceptions of the existence of favorable conditions that are conducive to the situational success of using cloud-based healthcare services.

2.4 Perceived Risk

Perceived risk is defined as the uncertainty that is experienced regarding the possible negative consequences of using a product or service [20]. When the level of uncertainty is more substantial, the level of perceived risk increases [21]. From the perspective of the elderly, there are several different kinds of perceived risk involved with the use of cloud-based healthcare services. These include performance, financial, privacy, and psychological risk. Performance risk is the probability of the health personnel harming a patient because of an incorrect decision based on inadequate information. Financial risk is the financial burden they place on the individual practices. Privacy risk for the elderly is the lack of control over personal information. Psychological risk is the potential that using the cloud-based healthcare services may cause psychological discomfort and tension because it could have a negative effect on the elderly's self-perception. Perceived risk has been used to aid in the understanding of users' adoption of, or resistance to, health IT [7]. Thus, perceived risk is an important factor that can potentially impact an elderly person's perception of cloud-based healthcare services. This study integrates perceived risk into the TPB model to gain a more comprehensive understanding of the behavioral intention of the elderly with regard to cloud-based healthcare services.

3 Research Model

Prior studies have argued that usage intentions are more appropriate than actual behavior because the former are measured contemporaneously with beliefs [22–24]. Certain studies have also chosen usage intention instead of actual usage as a dependent variable to investigate the health IT acceptance of users [25, 26]. Therefore, we considered the application of elderly people's intentions to use the cloud-based healthcare services as a dependent variable as adequate and desirable. Further, the cloud-based health services is a cloud platform for delivering health services, and activities are performed online and are processed virtually. Personal privacy data that hackers might steal are transmitted online. These concerns require a high level of trust and a low level of perceived risk before the elderly are willing to use the cloud-based healthcare services. The literature review indicated that numerous studies have provided empirical support indicating the significance of trust and perceived risk as a direct factor

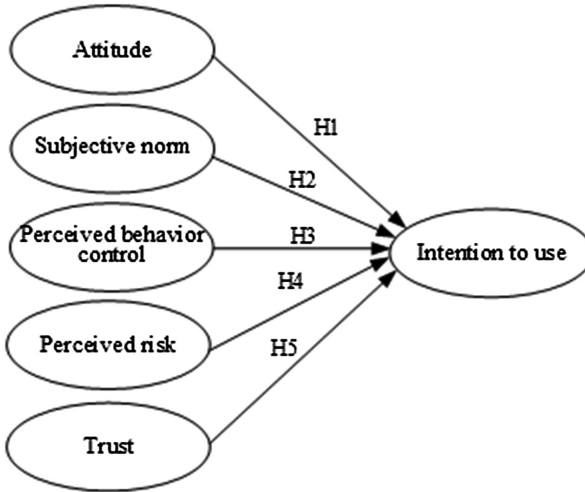


Fig. 1. Research framework

influencing the intentions of the user to engage in health activities [8, 9]. Thus, we extended the TPB model by adding trust and perceived risk construct to the research model. Figure 1 presents a pictorial depiction of the research model, which offers a description of the different dimensions and the development of theoretical arguments.

According to the TPB perspective, attitude, SN, and PBC are three direct antecedents for determining behavioral intention to use. We argue that, in the context of healthcare for Taiwanese senior citizens, there are three other potential linkages between attitude and behavioral intention, SN and behavioral intention, and PBC and behavior intention to use. Deng et al. [15] empirically used the TPB model to explain the behavioral intentions of older people toward mobile health services. Thus, we posit the following hypotheses:

H1. Attitude is positively related to the intention to use the cloud-based healthcare services.

H2. SN is positively related to the intention to use the cloud-based healthcare services.

H3. PBC is positively related to the intention to use the cloud-based healthcare services.

Trust is generally defined as one party's confidence. Trust has been identified as a predictor of usage intention [27]. Prior studies have provided empirical support indicating the importance of trust as a direct factor influencing an individual's intention to engage in healthcare activities [8, 9]. The elderly's use of healthcare services is subject to uncertainty and risk, which require improving the trust of cloud-based healthcare services. Consequently, this study proposes the following:

H4. Trust is positively related to the intention to use the cloud-based healthcare services.

Perceived risk increases the anticipation of negative outcomes, thereby leading to an unfavorable attitude that typically results in a negative effect on a user's intention to use [28, 29]. During the adoption process of cloud-based healthcare services, the elderly verify their perceptions of risks. If healthcare services are perceived to have a large risk, the elderly may resist using the cloud-based healthcare services. Thus, we propose the following hypothesis:

H5. Perceived risk is negatively related to the intention to use the cloud-based healthcare services.

4 Research Method

4.1 Questionnaire Development

The construct measures shown in Fig. 1 were all adopted from previous studies and were rated using a 5-point Likert scale; the anchors ranged from “strongly agree” to “strongly disagree.” Although previous studies have validated the questionnaire items, we conducted pretests by requesting several healthcare professionals to evaluate each item. To ensure validity and reliability, we conducted a pilot test with a sample that was representative of the actual respondents. We conducted structural equation modeling using partial least squares (PLS) estimations for the data analysis, because the PLS method requires a minimal sample size and has few residual distribution requirements for model validation [30].

4.2 Sample and Data Collection

The target participants were the elderly in Taiwan. Ten community care centers were successfully contacted to secure their collaboration. A total of 250 questionnaires were distributed through an administrator of the community care center, and 185 questionnaires were returned. We assessed nonresponse bias by comparing early and late respondents (e.g., those who replied during the first three days and the last three days). We found no significant difference between the two respondent groups based on the sample attributes (e.g., gender and age).

5 Research Results

The resulting 178 valid questionnaires constituted a response rate of 70 %. The majority of the questionnaire respondents were females (57.87 %) between the ages of 65 and 74 years (58.99 %). We tested the reliability and validity of the proposed model. Reliability was assessed based on a construct reliability greater than 0.8 [31]. Convergent validity was assessed based on the following three criteria: (a) item loading greater than 0.7 and statistically significant, (b) composite construct reliability (CR) greater than 0.80, and (c) average variance extracted (AVE) greater than 0.5 [32]. The discriminant validity between the constructs was assessed based on the criterion that the square root of the AVE

Table 1. Reliability and validity of the scale

Construct	Item loading	CR	AVE	Correlation					
				AT	SN	PBC	PR	TR	US
AT	.81–.89	.91	.70	.84					
SN	.85–.88	.90	.74	.41	.86				
PBC	.84–.90	.91	.77	.57	.51	.88			
PR	.81–.91	.89	.73	-.38	-.31	-.44	.85		
TR	.79–.96	.86	.76	.11	.01	.08	-.02	.87	
US	.89–.94	.94	.85	.46	.54	.55	-.36	.13	.92

Note: Leading diagonal shows the square root of AVE of each construct

Attitude (AT), Subjective norm (SN), Perceived behavior control (PBC), Perceived risk (PR), Trust (TR), intention to use (IN)

for each construct should be greater than the corresponding correlations with all the other constructs [31]. In this study, the construct reliabilities are all greater than 0.85. For the convergent validity, the item loadings are all greater than 0.7, and the AVEs range from 0.70 to 0.85. For the discriminant validity, the square root of the AVE for a construct is greater than its corresponding correlations with the other constructs. Table 1 shows the descriptive statistics of the principal constructs and the correlation matrix, respectively. These results indicate acceptable reliability, convergent validity, and discriminant validity.

The testing results in the structural model are indicated in Fig. 2. In this empirical study, we analyzed the elderly’s intention to use cloud-based healthcare services. The statistical testing conclusions support this research model. In this study, intention to use a cloud-based healthcare service was jointly predicted by attitude ($\beta = 0.14$,

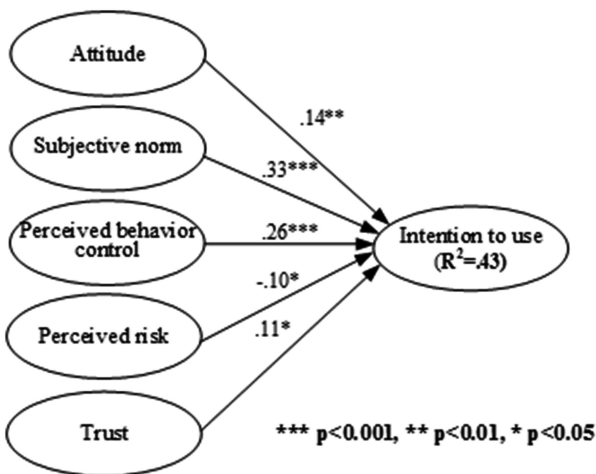


Fig. 2. Results of the structural model

standardized path coefficient, $p < 0.01$), SN ($\beta = 0.33$, $p < 0.001$), PBC ($\beta = 0.26$, $p < 0.001$), perceived risk ($\beta = -0.10$, $p < 0.05$), and trust ($\beta = 0.11$, $p < 0.05$). Together, these variables explained 43 % of the variance of intention to use. As a result, hypotheses 1, 2, 3, 4, and 5 were all supported.

6 Discussion

The results indicate that attitude, SN, and PBC are key determinants in the elderly's usage intentions. These findings are consistent with the results obtained by Ryu et al. [25] and Deng et al. [15]. The effects of these usage intention variables were significant in explaining the elderly's usage behavior because they are consistent with Ajzen [17], who maintained that the relative importance of attitude, SN, and PBC in predicting usage intention varies across behaviors and situations. The results showed that of all the main determinants, SN had the strongest effect on behavioral intention. When an elderly person has a greater perception that most people who are important to them think that they should use a new technology, they are more likely to commit to this perceived pressure and are more willing to use a cloud-based healthcare service. PBC was the influential factor in usage intentions toward the cloud-based healthcare services. This result coincides with the findings of previous studies on technology adoption [7, 26] and suggests that the elderly are likely to engage in cloud-based healthcare services when they believe they have the ability to use the new technology. Attitude was an influential factor in the elderly's intention to use cloud-based healthcare services, although its effect was smaller than that of either SN or PBC. Trust was also found to have a significant positive effect on the intention to use cloud-based healthcare services. To increase the acceptance of cloud-based healthcare services, healthcare service providers need to develop strategies that improve the elderly's trust in the underlying technology. As hypothesized, perceived risk increases the anticipation of negative outcomes, thereby leading to an unfavorable attitude that typically results in a negative effect on the elderly's intention to use such a healthcare service.

In summary, the main contribution of this study is that it is the first to explore the elderly's usage behavior using existing social psychology theories. The TPB approach, which was adopted for the model, provides a more complete set of antecedents that better explain the intention to employ a specific technology (i.e., cloud-based healthcare services), thereby enhancing the practical contributions of this study. We extended the model by incorporating trust and perceived risk and examined its influence on the elderly's intentions to adopt a new health IT. All the main constructs, including the new constructs (i.e., trust and perceived risk), were found to have a significant effect on elderly people's intentions to use cloud-based healthcare services. The results indicate that the model provides a good understanding of the factors that influence the intention to use cloud-based healthcare services. We offer implications regarding medical practice and academic research that are based on our findings. We hope to encourage future researchers to (a) further examine the relative effectiveness of the existing, legally binding, and personal information protection act and to (b) improve the effectiveness of the information security mechanism in the healthcare context.

References

1. Council for Economic Planning and Development.: Health and Vital Statistics (1): General Health Statistics. Taiwan: Department of Health, Executive Yuan Republic of China (2015)
2. Ministry of Interior, Executive Yuan, Taiwan. General Population Profile of Taiwan (2012). <http://www.moi.gov.tw>
3. Chen, C.S., Peng, Y.I., Lee, P.C., Liu, T.C.: The effectiveness of preventive care at reducing curative care risk for the Taiwanese elderly under National Health Insurance. *Health Policy* **119**, 787–793 (2015)
4. National Health Insurance Administration.: National Health Insurance Research Database (2011). <http://www.nhri.org.tw/nhird/>. Accessed 08 Sept 2015
5. Chen, H., Cheng, B.C., Liao, G.T., Kuo, T.C.: Hybrid classification engine for cardiac arrhythmia cloud service in elderly healthcare management. *J. Vis. Lang. Comput.* **25**(6), 745–753 (2014)
6. Lai, J.Y., Wang, J.: Switching attitudes of Taiwanese middle-aged and elderly patients to-ward cloud healthcare services: an exploratory study. *Technol. Forecast. Soc. Change* **92**, 155–167 (2014)
7. Hsieh, P.J.: Physicians' acceptance of electronic medical records exchange: an extension of the decomposed TPB model with institutional trust and perceived risk. *Int. J. Med. Inform.* **84**(1), 1–14 (2015)
8. Tung, F.C., Chang, S.C., Chou, C.M.: An extension of trust and TAM model with IDT in the adoption of the electronic logistics information system in HIS in the medical industry. *Int. J. Med. Inform.* **77**(5), 324–335 (2008)
9. Egea, J.M.O., González, M.V.R.: Explaining physicians' acceptance of EHCR systems: an extension of TAM. *Comput. Hum. Behav.* **27**, 319–332 (2011)
10. Ajzen, I.: From intentions to actions: a theory of planned behaviour. In: Kuhl, J., Beckmann, J. (eds.) *Action-Control: From Cognition to Behavior*, pp. 11–39. Springer, Heidelberg (1985)
11. Health IT Industry Research.: 2014 HIMSS Analytics Cloud Survey (2014). <http://www.himss.org/ResourceLibrary/genResourceDetailPDF.aspx?ItemNumber=41958>
12. Huang, J.C.: Remote health monitoring adoption model based on artificial neural networks. *Expert Syst. Appl.* **37**, 307–314 (2010)
13. Huang, J.C., Lee, Y.C.: Model construction for the intention to use telecare in patients with chronic diseases. *Int. J. Telemed Appl.* **2013**, 1–6 (2013)
14. Sun, Y., Wang, N., Guo, X., Peng, Z.: Understanding the acceptance of mobile health services: a comparison and integration of alternative models. *J. Electron. Commer. Res.* **14**(2), 183–200 (2013)
15. Deng, Z., Mo, X., Liu, S.: Comparison of the middle-aged and older users' adoption of mobile health services in China. *Int. J. Med. Inform.* **83**(3), 210–224 (2014)
16. Fishbein, M., Ajzen, I.: *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Addison-Wesley, Reading (1975)
17. Ajzen, I.: The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* **50**(2), 179–211 (1991)
18. Holden, R.: Physicians' beliefs about using EMR and CPOE: in pursuit of a contextual-ized understanding of health IT use behavior. *Int. J. Med. Inform.* **79**(2), 71–80 (2010)
19. Hosmer, L.T.: Trust: the connecting link between organizational theory and philosophical ethic. *Acad. Manag.* **20**(2), 379–403 (1995)
20. Featherman, M.S., Pavlou, P.A.: Predicting e-services adoption: a perceived risk facets perspective. *Int. J. Hum. Comput. Stud.* **59**(4), 451–474 (2003)

21. Ayanso, A., Herath, T.C., O'Brien, N.: Understanding continuance intentions of physicians with electronic medical records (EMR): an expectancy-confirmation perspective. *Decis. Support Syst.* **77**, 112–122 (2015)
22. Agarwal, R., Prasad, J.: Are individual differences germane to the acceptance of new information technologies? *Decis. Sci.* **30**(2), 361–391 (1999)
23. Chang, M.K.: Predicting unethical behavior: a comparison of the theory of reasoned action and the theory of planned behavior. *J. Bus. Ethics* **17**(16), 1825–1834 (1998)
24. Chau, P.Y.K., Hu, P.J.H.: Investigating healthcare professionals' decisions to accept telemedicine technology: an empirical test of competing theories. *Inform. Manag.* **39**(4), 297–311 (2002)
25. Ryu, M.H., Kim, S., Lee, E.: Understanding the factors affecting online elderly user's participation in video UCC services. *Comput. Hum. Behav.* **25**(3), 619–632 (2009)
26. Hung, S.Y., Ku, Y.C., Chien, J.C.: Understanding physicians' acceptance of the medline system for practicing evidence-based medicine: a decomposed TPB model. *Int. J. Med. Inform.* **81**(2), 130–142 (2011)
27. Hampton-Sosa, W., Koufaris, M.: The effect of web site perceptions on initial trust in the owner company. *Int. J. Electron. Commerce.* **10**(1), 55–81 (2005)
28. Benlian, A., Hess, T.: Opportunities and risk of software-as-a-service: findings from a survey of IT executives. *Decis. Support Syst.* **52**(1), 232–246 (2011)
29. Polites, G.L., Karahanna, E.: Shackled to the status Quo: the inhibiting effects of incumbent system habit, switching costs, and inertia on new system acceptance. *MIS Q.* **36**(1), 21–42 (2012)
30. Chin, W.W., Marcolin, B.L., Newsted, P.R.: A partial least squares latent variable modeling approach for measuring interaction effects: results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study. *Inform. Syst. Res.* **14**(2), 189–217 (2003)
31. Chin, W.W.: Issues and opinion on structural equation modelling. *MIS Q.* **22**(1), 7–16 (1998)
32. Fornell, C., Larcker, D.: Structural equation models with unobservable variables and measurement error: algebra and statistics. *J. Mark. Res.* **18**(3), 382–388 (1981)