

DOES KNOWLEDGE MATTER? THE ROLE OF M-HEALTH LITERACY TO THE ACCEPTANCE OF M-HEALTH APPLICATIONS

Doan Thi Lien Huong^{1*}, Tran Dinh Long¹

¹The University of Danang - University of Economics

*Corresponding author: huong.dtl@due.edu.vn

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Abstract - With the proliferation of the Internet and wireless technology in many areas of people's life; the use of mobile phones; especially smartphones for health practices and information (mHealth) has increasingly been prevalent. Based on Technology Acceptance Model (TAM) and the Innovation Diffusion Theory (IDT); this study examined the role of mHealth literacy and other factors toward the adoption of wellness apps among the users in Danang city. The results confirmed the impact of mHealth Literacy on (1) intention to use health apps (2) the perceived usefulness and (3) the perceived ease of use. While the perceived usefulness and the perceived ease of use are found to exert influence on the intention of use; the role of privacy and security concerns on intention to use was rejected.

Key words - Health application; mHealth literacy; mHealth acceptance; Technology Acceptance Model (TAM)

1. Introduction

With the proliferation of the Internet and wireless technology in almost every area of people's life, mobile phones have become the most widespread personal communication devices in the world. Consequently, the use of mobile phones, especially smartphones for health practices and information (mHealth) has increasingly been prevalent.

According to WHO Global Observatory for eHealth [1], mHealth is defined as: "Medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices. MHealth involves the use and capitalization on a mobile phone's core utility of voice and short messaging service (SMS) as well as more complex functionalities."

With 66.5 million smartphone users in 2021, accounting for 69.5% of the population [2], Vietnam is expected to become an exceptionally important market for health applications. However, research of mHealth in Vietnam remains sparse. More research is consequently needed to explore what makes health applications useful and usable; and how to promote and increase their use among Vietnamese Internet users. In addition, none of previous mHealth research in Vietnam took into consideration the fact that health applications require users to achieve a certain level of knowledge and skills to search, obtain, process, understand, and communicate health-related information [3].

In this study, we aim to understand the factors explaining the adoption of health application among smartphone users in Vietnam. We draw upon the technology acceptance model (TAM) and the Innovation

Diffusion Theory to examine the role of mHealth literacy in explaining the acceptance of health applications. We aimed to answer the question "How does mHealth literacy affect the adoption of health apps?" and "What are other factors leading to the adoption of health apps?" The factor "Privacy and Security concern" is added to the model to tailor to the online context, where privacy and data security become an extremely important issue.

In the current study, we focus only on mobile applications for wellness purposes. Wellness applications do not necessarily aim to prevent any specific disease, but rather, to encourage the healthy behaviors of the users. The most used applications are designed for daily eating diet, supporting fitness, and physical activities. It has been shown by health research that the use of Web information systems and mobile apps leads to increased health literacy, positive outcomes, more proactive health behavior [4] and consequently reducing people's spending on disease treatment.

2. Theoretical foundations

2.1. Technology Acceptance Model (TAM)

TAM is one of the most well-known models in Technology adoption research. Davis, Bagozzi, & Warshaw [5] developed TAM based on the Theory of Reasoned Action (TRA) [6]. TRA suggests that social behavior is driven by an individual's attitude toward a specific behavior. However, it does not specify what beliefs would be important in a particular situation. TAM posits that an individual's behavioral intention to use technology is determined by his or her perception of the usefulness of the technology (perceived usefulness-PU) and the degree to which the person believes that using technology will be free of effort (perceived ease of use - PEOU). These perceptions eventually influence a user's attitude. This attitude, in turn, determines the intention and behavior of using the technology.

2.2. Innovation Diffusion Theory

Rooted in social science fields, Rogers' Innovation Diffusion Theory (IDT) explains how innovation is introduced and accepted within a social system. According to IDT, the innovation is more likely to be adopted if it is better than the idea, program, or product it replaces (relative advantage); if it is compatible with the potential customers' past experiences, beliefs (compatibility); if it is easy to understand and use (complexity); if it is trialable and observable before adoption (trialability and observability) [7].

The concept of compatibility in IDT has a lot in common with the concept “literacy”. Both can be acquired and improved when people accumulate knowledge and skills from experiencing projects/ ideas/ programs similar to the innovation. We may expect that the more technology-literate people are, the more likely they find the innovation compatible with their value, their work style, their belief. Both tech-literacy and compatibility when improved, will result in a faster rate of adoption of innovation. Drawing on this similarity of these two concepts, we added the concept “mHealth literacy” to the TAM-styled model to explain the intention to use health apps.

3. Research Model and Hypothesis

3.1. Perceived Usefulness (PU)

PU is one of the most important variables of TAM research. PU is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance” [8]. TAM literature suggested that the higher degree of perceived usefulness of a technology/system, the stronger the intention for users to utilize it. In the context of mHealth apps, we expect that whether an individual decides to use a specific health app would depend on how they perceive the benefits offered by the app. More specifically, for users to adopt health applications, it is essential that they find the applications useful for improving their lifestyle, for supporting them to increase the wellness. Thus we hypothesize that:

H1: Perceived usefulness is positively associated with the intention to use health applications

3.2. Perceived Ease of Use

In TAM literature, perceived ease of use (PEOU) is defined as “the degree to which a person believes that using a particular system would be free from effort” [8]. As noted earlier, TAM research indicates that PEOU is a significant determinant of the intention to use technology [9], [10], [11]. Hence, we expect that:

H2: Perceived ease of use is positively associated with health application intention to use

TAM theory as in [11], [9] also suggested that PEOU exerts an impact on the PU. It is explained that the technology which requires less effort from users (easy to use), will enable them to redirect their efforts to other relevant tasks, thus making them regard the technology as highly useful. These arguments are supported by many empirical studies [12], [13]. We therefore hypothesize:

H3: Perceived ease of use is positively associated with the perceived usefulness of health application

3.3. Mhealth literacy

The term eHealth literacy was first introduced by [14]. It was then defined as “the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem.” Consequently, the concept of mHealth literacy in this study entails the ability to use the mobile phone to find, evaluate and apply

health information to deal with a health problem.

As previously mentioned, eHealth literacy shares many characteristics with the concept of compatibility of IDT, especially their role in facilitating the acceptance of technology/innovation. In fact, prior studies showed that the use of information technologies for health-related purposes requires a specific kind of literacy [15]. It implied that the more competent and confident relating to health apps, the more likely users perceive the applications accessible and useable. Hence the following hypothesis is proposed:

H4: mHealth literacy is positively associated with the perceived ease of use of health application

The role of eHealth knowledge/literacy to eHealth’s acceptance has empirically been supported by many past studies. In fact, Vance Wilson and Lankton [15], in their research on the patients’ acceptance of provider-delivered eHealth, found that patients with high information-seeking preference will tend to accept eHealth, given that eHealth increases the availability of information and hence facilitate the seeking information process. Alshahrani, Stewart and MacLure [16] contented that educational factors (e.g. level of education, training, language proficiency and digital literacy) influenced an individual’s attitude towards technology adoption and acceptance [17]. Mackert [16] recommended that mHealth must be adapted to the health literacy levels of different mHealth users in order to reach and influence users effectively.

In the context of health apps, the apps are generally useful in supporting users to achieve their health goals such as improving their overall wellness or quality of life (through proper diet and regular exercise) [18]. If people are more knowledgeable and confident about functionalities of health apps (e.g. about how they work, how they can help user achieve their health objective), they will be more motivated to adopt the apps in order to realize their health goals. Hence, mHealth literacy can be a predictor of intention to use (ITU) health app. Thus, we assumed:

H5. MHealth literacy is positively associated with the intention to use health application

In addition, mHealth literate people are expected to have more knowledge and experience to figure out how to use mobile devices to search for and evaluate the information to tackle a health problem in an effective way. Then it is the more likely that they better understand the way health applications work and how they may contribute to improving their wellness. Put in another way, the more people knowledgeable of health apps, the more likely they perceive the benefits that health apps offer to users. Hence we suggest that:

H6. MHealth literacy is positively associated with perceived usefulness of health applications

3.4. Privacy and Security Concern (PSC)

According to Giota and Kleftras [19], many wellness applications collect a large number of personal information such as name, phone number, email address,

age, gender, and photos. The user's lifestyle information such as food consumption and exercise has been also cataloged.

However, there is a risk that information people provided to those apps may be distributed to the developer, to third-party sites the developer may use for functionality reasons, and to third-party marketers and advertisers [19]. Similarly, there is a strong possibility that the applications lack reliable security, as they might transmit unencrypted personal data over insecure network connections, or allow ad networks to track users, that way raising serious concerns about the privacy and confidentiality of user information. Consequently, there are risks that the privacy and security of users' personal health information are revealed without the consent of information owners.

In fact, Atienza [20] showed that consumers were highly aware of and frequently considered the tradeoffs between the privacy/security of using mHealth technologies and the potential benefits. The authors also showed two most important issues for consumers: having control over mHealth privacy/security features and trust in health app providers.

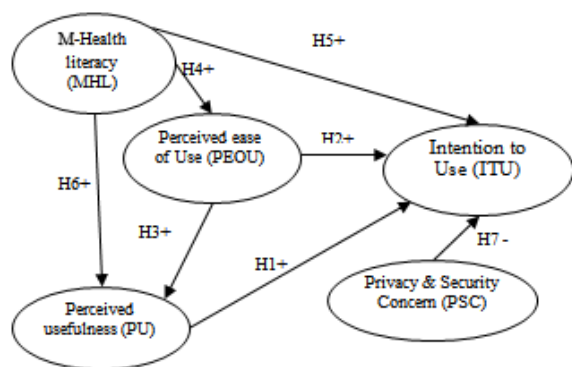


Figure 1. Research Model

Hence, we might expect that the more concerned people are about privacy and security issues regarding the use of health apps, the less likely they intend to use the application. Hence, we propose that:

H7. Privacy & Security concern is negatively associated with the intention to use health application

Seven hypothesis of the study are summarized and presented in Figure 1.

4. Methodology

Regarding the data collection, an online survey via Google Doc was conducted. We sent out self-administered online survey to 600 randomly selected people with the help of the Danang Department of Health, Da Nang Family General Hospital, and a healthcare app startup in Danang. Only respondents who indicated to be using wellness apps at the time of the study were considered. If they indicated not to use any wellness app on either their smartphones or tablets the survey was terminated. Out of 600 distributed questionnaires, we received 253 usable responses (response rate of $277/600 = 46.17\%$; usable rate: $253/277 = 91.3\%$).

Regarding the measurement, we using Likert 5 point scales to measure all variables. The items were adapted from prior studies with minor modifications to tailor them to the mHealth context. We got inspired and adapted items for "intention to use" from [21], [22]; items for "perceived usefulness" and "perceived ease of use" from [9], items for mHealth literacy from [7], items for Privacy and Security concern from [23]. Details of items and their sources are provided in Appendix.

5. Data Analysis and Results

5.1. Sample characteristics

Table 1 presents demographics of the sample. It shows that 93.2% of the sample held a university degree or above. People aged from 20-45 composed the major group of respondents (74.6%).

Table 1. Sample Characteristics

Characteristics	Criteria	N=253	%
Gender	Male	110	43.48%
	Female	143	56.52%
Age	20 – 35	102	40.32%
	36 – 45	87	34.39%
	46 – 55	46	18.18%
	56 – 60	18	7.11%
Education	High school	16	6.32%
	University	199	78.66%
	Postgraduate	36	14.23%
	Other	2	0.79%

5.2. Data Analysis

We used SmartPLS 3.3.3 to analyze data following PLS technique. Similar to CB-SEM technique, PLS model is a structural equation modeling that can specify and estimate simultaneously the relationships among the underlying conceptual constructs (structural model) as well as the one between measures and constructs (measurement model). This method is argued to outperform CB-SEM e.g. LISREL, AMOS in estimating the paths among constructs that are typically biased downward by measurement error [24]. Furthermore, PLS-SEM seems a better technique to deal with non-normality and small-to-medium sample sizes [25], [24].

Table 2. Convergent validity

	Cronbach's Alpha	CR	AVE	Indicator	Loadings	Indicator Reliability
Intention to Use (ITU)	0.829	0.897	0.745	ITU1	0.86	0.74
				ITU2	0.866	0.75
				ITU3	0.863	0.745
M-Health Literacy (MHL)	0.899	0.937	0.832	MHL1	0.913	0.834
				MHL2	0.915	0.837
				MHL3	0.909	0.826
Perceived Ease of use (PEOU)	0.835	0.889	0.668	PEOU1	0.829	0.687
				PEOU2	0.848	0.719
				PEOU3	0.813	0.661
				PEOU4	0.777	0.604
Perceived Usefulness	0.896	0.923	0.707	PU1	0.863	0.745
				PU2	0.862	0.743

ss (PU)				PU3	0.859	0.738
				PU4	0.813	0.661
				PU5	0.804	0.646
Privacy Security Concern (PSC)	0.864	0.907	0.71	PSC1	0.781	0.61
				PSC2	0.838	0.702
				PSC3	0.888	0.789
				PSC3	0.86	0.74

We followed two-step analytical procedure recommended by [26] to examine the measurement model first and then the structural model.

5.3. Measurement Model

The measurement model should be assessed on its convergent validity and discriminant validity. Convergent validity indicates the extent to which the items of a scale that are theoretically related should correlate highly. Composite reliability (CR) and average variance extracted (AVE) are the two most common indices for convergent validity of measures. CR of a construct is commonly used to check whether the scale items measure the construct in question or other constructs. AVE reflects the overall amount of variance in the indicators accounted for by the latent construct. CR and AVE should be more than 0.7 and 0.5 respectively [27]. We used SmartPLS 3.3.3 to analyze data following PLS technique. Similar to CB-SEM technique, PLS model is a structural equation modeling that can specify and estimate simultaneously the relationships among the underlying conceptual constructs (structural model) as well as the one between measures and constructs (measurement model). This method is argued to outperform CB-SEM e.g. LISREL, AMOS in estimating the paths among constructs that are typically biased downward by measurement error [24]. Furthermore, PLS-SEM seems a better technique to deal with non-normality and small-to-medium sample sizes [25], [24].

Table 2 summarizes the Cronbach's Alpha, CR, AVE of the constructs, which are all larger than recommended levels. The individual indicator reliability are satisfactorily larger than the preferred level of 0.7. [28], [29].

Table 3. HTMT values

Paths	Value	2.5%	97.5%
MHL -> ITU	0.706	0.609	0.796
PEOU -> ITU	0.534	0.399	0.652
PEOU -> MHL	0.382	0.246	0.505
PSC -> ITU	0.63	0.503	0.741
PSC -> MHL	0.595	0.492	0.693
PSC -> PEOU	0.549	0.417	0.673
PU -> ITU	0.718	0.618	0.807
PU -> MHL	0.607	0.506	0.707
PU -> PEOU	0.572	0.455	0.685
PU -> PSC	0.743	0.658	0.829

Discriminant validity refers to the extent to which a construct is empirically distinct from other constructs [26]. Three methods can be used to assess discriminant validity: the cross-loading criterion, the Fornell-Larcker criterion, and the Heterotrait-Menotrait ratio (HTMT)

[24]. Despite the widespread application of cross-loadings and the Fornell-Larcker criterion in evaluating the discriminant validity of a PLS model, Henseler, Ringle, and Sarstedt [30] argued that these methods have drawbacks. They recommended using the Heterotrait-Menotrait (HTMT) method instead to better detect the lack of discriminant validity. Thus, we employed the HTMT criterion to assess the discriminant validity of our model, as depicted in Table 3. As all HTMT values generated by bootstrap technique are well below the threshold of 1.0, discriminant validity of all constructs of the proposed conceptual model is ensured.

5.4. Structural Model

PLS estimated path coefficients of and associated t-values are summarized in Table 4. T-values were calculated by using the bootstrap resampling procedure in PLS. Six out of seven paths exhibited a t-value significant at 0.05 level.

Table 4. Structural path estimation

H#	Path	β	P Value	Comment
H1	PU -> ITU	0.301	0	Supported
H2	PEOU -> ITU	0.137	0.013	Supported
H3	PEOU -> PU	0.357	0	Supported
H4	MHL-> PEOU	0.344	0	Supported
H5	MHL -> ITU	0.347	0	Supported
H6	MHL -> PU	0.425	0	Supported
H7	PSC -> ITU	0.094	0.193	Rejected

Critical t-values for a two-tailed test are 1.65* (significance level =0.1), 1.96** (significance level = 0.05) and 2.58*** (significance level =0.001)

R² values from PLS calculation show that three constructs including mHealth literacy (MLH), perceived ease of use (PEOU), and perceived usefulness (PU) explained 51.1% of the variance in the intention to use (ITU); mHealth literacy (MHL) alone explained 11.9 % variance of perceived ease of use (PEOU), mHealth literacy (MHL) along with perceived ease of use (PEOU) explained 41.3% of the variance of the Perceived Usefulness (PU).

Among determinant factors of ITU, MHL showed the strongest impact ($\beta=0.347$, $t=5.704$), followed by PU ($\beta=0.301$, $t=4.108$) and PEOU ($\beta=0.137$, $t=2.481$). The result also showed that PSC has no significant impact on ITU ($\beta=0.094$, $t=0.193$)

We ran the blindfolding function of SMARTPLS Version 3.3.3 to calculate Q². Results show that PEOU, PU, and MHL highly predicted the intention to use (ITU) with a high Q² (0.373). MHL and PEOU also moderately predicted their endogenous latent variable (intention to use) with a medium Q² (0.286). However, MHL has a weak predictive value on PEOU (0.07). In sum, all endogenous variables had a Q value above 0, indicating that the proposed model was relevant [28].

6. Results and discussion

This study aimed to better understand the importance of mHealth literacy as well as the role of other

determinants such as perceived usefulness, perceived ease of use, and privacy and security concerns to then intention to use health applications.

Analysis showed that the measurement model was confirmed with an adequate convergent and discriminant validity. The structural model provided a good predictive relevance with six out of seven paths being found statistically significant.

The study showed that mHealth literacy has the most substantial impact on intention to use, followed by perceived usefulness and perceived ease of use respectively. The influence of mHealth literacy on intention to use is consistent with a lot of previous studies [7], [17].

These results suggest that app developers and marketers should design the app and marketing campaign which provide people with more opportunities to experience the app before officially committing resources. This will help potential users accumulate relevant experience, knowledge (e.g. increasing mHealth literacy) which in turn encourages their adoption of health apps.

Given the important impact of mHealth literacy on the perceived usefulness and the perceived ease of use respectively; the health apps should be appropriately designed so that low health-literate audiences can regard the apps as useful and easy to use. The relationship between the perceived ease of use and the perceived usefulness suggests that health apps providers must seriously take into account the app's usability if they want to ensure user's perception of its usefulness. Our results also imply that public health authorities should develop effective mHealth literacy campaigns if they would like to promote the use of healthcare apps among low educated populations.

Our study surprisingly revealed that the "privacy and security concerns" has no impact on intention to use, conflicting with prior studies in developed countries context [19], [20], [31]. However, this finding is in line with the findings of a few studies on the perception of online information privacy in Vietnam. For example, Sriratanaviriyakul et al. [32] showed that privacy concerns do not correlate well with online social network users' intentions. According to the authors, the collectivists' culture of Vietnam makes people more comfortable in sharing their personal information and life experiences. Similarly, Phan, Ho, and Le Hoang [33] found that the intention of using e-wallets in payment by young Vietnamese is not influenced by the concern of security and privacy. Put it in another way, Internet users in Vietnam seem not care much about security and privacy when they go online. This finding has sounded an alarm about the current situation in Vietnam where Internet users are negligent, careless, and not concerned about their privacy and security. The government should develop and implement programs to raise people's awareness of this issue. At the same time, it is necessary to build legal infrastructures regarding privacy and information protection to prevent app providers from exploiting user information for profit purposes, and at the same time protecting the interests of users in the event of risks.

Despite the mentioned contributions, this study has

several limitations that must be acknowledged and considered for future research. Firstly, the sample mainly consisted of university graduates who may more excel in using the Internet and more health-literate than the general population in Vietnam. To improve the research generalizability, future studies should collect samples with greater educational diversity. Secondly, although this research model is constructed based on theoretical assumptions and existing literature, alternative models should be explored and tested; for example, testing mHealth literacy as the predictor of privacy and security concerns. Finally, the theoretical model accounts for 40.9 % of the variance of the construct "intention to use", which suggests that some important predictors may be missing. As recommended by TAM studies, these moderators may include individual factors such as gender, age, experience, voluntariness [34], [35].

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APPENDIX

Item	Statement
ITU1	I intend to continue to use a health app
ITU 2	I would use health apps in my daily life
ITU 3	I don't see any problem in continuing to use the health app.
MHL1	I know how to find helpful health resources on the mobile phone.
MHL2	I feel confident in using information from the mobile phone to make health decisions
MHL3	I have the skills I need to evaluate the health resources I find on the mobile phone
PEOU1	Health apps' interface is simple and easy for use
PEOU2	It would be easy for me to be skillful at using health apps
PEOU3	Learning to use health apps is easy for me
PEOU4	I find easy and convenient to use health apps
PU1	Using health apps helps me change my lifestyle positively
PU2	Using health apps would improve my wellness
PU3	Using health apps make me healthier
PU4	Using health apps help me accomplish my health goals more quickly
PU5	Using health apps make me feel better
PSC1	I believe that health app providers should ask for users' consent to use their information when using have privacy & information security policy
PSC2	I consider the privacy and security of personal health information important
PSC3	I believe that health app providers should inform users of their policy of privacy and security
PSC4	I believe that protecting users' privacy & health information is the responsibility of health app provider