

Smart Phone Acceptance among Physicians: Application of Structural Equation Modelling in the Largest Iranian University

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ABSTRACT

Background: The present study aimed to determine attitudes and effective factors in the acceptance of smart phones by physicians of the largest University of Medical Sciences in the south of Iran.

Methods: This cross-sectional study was performed using Structural Equation Modelling (SEM) in 2014. Study participants included 200 physicians working in the hospitals of Shiraz University of Medical Sciences selected through two-stage stratified sampling, but 185 participants completed the study. The study data were collected using a researcher-made questionnaire completed through a 5-point Likert scale. The content validity of the questionnaire was confirmed by a panel of experts, its construct validity by confirmatory factor analysis, and its reliability by Cronbach's alpha of 0.802. All data analyses were performed using SPSS (version 22) and LISREL (version 8.8).

Results: Results showed that most physicians had a desirable attitude towards using smart phones. Besides, the results of SEM indicated a significant relationship between attitude and compatibility, observability, personal experience, voluntariness of use and perceived usefulness. Moreover, some important fitness indices revealed appropriate fitness of the study model ($p=0.26$, $X^2/df=1.35$, $RMR=0.070$, $GFI=0.77$, $AGFI=0.71$, $NNFI=0.93$, $CFI=0.94$).

Conclusion: The results revealed that compatibility, observability, personal experience, voluntariness of use and perceived usefulness were effective in the physicians' attitude towards using smart phones. Thus, by preparation of the required infrastructures, policymakers in the field of health technology can enhance the utilization of smart phones in hospitals.

Keywords

Health Information Management, Technology, Smart Phone, Structure Equation Modelling, Physician, Iran

Introduction

In recent years, using smart phones has found its position in the field of health and treatment, facilitating a large number of tasks for physicians and patients. Up to now, more than a hundred functional programs have been designed for the assessment of individuals' health through smart phones, which can even change them into advanced personal devices, such as a portable ultrasound device.

Since the introduction of information and communication technolo-

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Received: 5 January 2016
Accepted: 15 April 2016

gies, researchers have evaluated their effects and consequences from various perspectives. By increase of investment in new information and communication technologies, investigation of acceptance of these technologies has attracted the researchers' attention, attempting to identify the effective factors in acceptance of technologies so as to increase their application [1]. For instance, Phua stated that instruments such as smart phones, could be useful in the management of personal information, obtaining pharmaceutical information, and access to medical resources [2]. The results of the study by Chatterley also indicated that medical students mostly used such devices for calendar, pharmaceutical information, E-mail, medical references, dictionary, clinical computations, differential diagnosis of diseases and daily notes [3]. Moreover, the findings of the study by Stroud demonstrated that the utilization of smart phones played a critical role in clinical decision making and improvement of the patients' health and safety [4].

Considering the importance of acceptance of technologies by users, many researchers have modified the Technology Acceptance Model (TAM) to improve its interpretability. This way, they not only modified the model's structure, but also added external and mediator variables, and created models with higher predictive ability by investigation of the relationships among all the variables [5].

In previous studies, TAM and Diffusion of Innovation (DOI) theory were used to investigate the acceptance of new technologies, even portable ones [6, 7]. Based on a search in databases, TAM and DOI theories are more functional and reliable compared to other models. They have also been used by a large number of researchers in various fields [8, 9].

Kim and Ammeter conducted a study in 2014 to predict the acceptance of Personal Information System (PIS), using integrated emission model. They came to the conclusion that quality, compatibility, complexity and related benefits directly affected the intention to

use the technology [10]. Similarly, Ensar Meik performed a research in 2014 to determine the effective factors in the acceptance of smart phones. The results of that study revealed that perceived benefits and perceived ease of use affected the acceptance of the technology, while security, privacy and perceived usefulness had no effects [11]. In the same line, Putzer et al. carried out a research in 2010 to assess the new effective factors in the acceptance of smart phones among nurses. They came to the conclusion that observability, compatibility, job relevance, internal environment and external environment had an impact on the nurses' attitude towards using smart phones [12]. They also conducted another study in 2012 to determine new effective factors in physicians' utilization of smart phones for clinical decision making. The results of that study also revealed that compatibility, job relevance, internal environment, observability, personal experience and external environment were effective in the physicians' attitude towards using smart phones [5]. The present study aimed to determine the attitude towards and effective factors in utilization of smart phones by physicians working in the hospitals affiliated to Shiraz University of Medical Sciences, Shiraz, Iran based on the combination of modified TAM and DOI theory.

Material and Methods

Study Design

This applied, cross-sectional, descriptive-analytical study was conducted in the hospitals affiliated to Shiraz University of Medical Sciences. The study aimed at determining the effective factors in the acceptance of smart phones by physicians. The assumed effective factors in the physicians' attitude towards using smart phones are presented in Figure 1.

Sample

Considering the fact that the study population consisted of the physicians working in the



Figure 1: The proposed model of the study

hospitals of Shiraz University of Medical Sciences, the participants were selected through two-stage stratified sampling. In doing so, the first 7 hospitals were selected using simple random sampling. Then, some physicians in each hospital (a total of 200 physicians) were selected through simple random sampling.

Materials and Procedure

In order to determine the effective factors in the acceptance of smart phones by physicians, modified TAM was used in the current study. This model contains 9 factors, including compatibility, observability, job relevance, personal demographic, personal experience, internal environment, voluntariness of use, security and privacy and perceived usefulness. Then, a hypothesis was considered for the relationship between each factor and physicians' attitude. Compatibility and observability were obtained from DOI theory. Personal demographic and personal experiences were also entered into the model due to their important relationship with attitude towards utilization of smart phones (Figure 1). Rogers also stated that personal features were of utmost importance in the process of acceptance of technologies [13]. Moreover, internal environment was

selected as the independent variable because it seemed to be effective in the acceptance of new technologies. In fact, the higher the compatibility of the user with the smart phone, the higher the probability of its acceptance will be. Job relevance and observability by colleagues increase the chance of acceptance of technologies, as well. Two other factors included in the model were voluntariness of use and perceived usefulness. In addition, perceived usefulness, which is a motivating factor in using information technologies, and security and privacy, which is among the important barriers against acceptance of technologies, were obtained from the study performed by Pikarainen [14].

After all, a questionnaire was prepared including three sections. The first section contained definition of smart phones and description of their applications for physicians. The second part of the questionnaire included 32 questions measuring the assumed effective factors in the acceptance of smart phones. In this part, attitude, compatibility, observability, job relevance, personal demographic, personal experience, internal environment, security and privacy, voluntariness of use and perceived usefulness were assessed by 4, 3, 2, 3, 3, 2, 4, 5, 4, and 2 questions, respectively. The questions were responded through a 5-point Likert scale with the following options: "completely agree" (5), "agree" (4), "usual" (3), "disagree" (2) and "completely disagree" (1). Finally, the last part of the questionnaire consisted of questions about the participants' demographic characteristics.

In order to determine the desirability of the physicians' attitude towards acceptance of smart phones, the mean scores of this dimension were calculated and compared to 3 (the average level), using sample t-test. The scores >3 and <3 represented desirable and undesirable conditions, respectively.

Due to the periodical rotation of some physicians in the study hospitals, the questionnaires were distributed and collected in a short period of time (almost a month) to reduce the proba-

ble problems in the process of data collection. In order to gather the study data, the questionnaires were distributed among physicians. In case the physicians could not complete the questionnaires due to any reason (not being in the hospital, being busy and being willing to complete the questionnaire through the Internet), the designed questionnaire in Google docs was sent to their E-mail. After all, 185 questionnaires were completed by the physicians (response rate=92.5%). The content and face validity of the questionnaire were confirmed by a panel of experts, its construct validity by confirmatory factor analysis, and its reliability by Cronbach's alpha of 0.802.

Data Analysis

In order to analyze the study hypotheses, descriptive statistics (mean and frequency) were performed by SPSS statistical software, version 22 and Structural Equation Modeling (SEM) was carried out by LISREL software, version 8.

Results

The study results indicated that 104 physicians (56.2%) were female and 81 (43.8%) male. In addition, most respondents (65, 35.13%) belonged to 25-30 year age group. The most popular brands of smart phones were Samsung (33.9%), Sony (16.5%) and Apple (11.6%), while the least popular ones were Huawei and others (5%). Besides, 18.2% of the physicians were not willing to mention the brand of their mobile phones.

In this study, Pearson's correlation coefficient (R) and regression (R^2) were used to determine the relationship between each research variable and the physicians' attitude towards acceptance of smart phones. The results revealed a significant direct relationship between attitude and observability, compatibility, job relevance, internal environment, voluntariness of use, perceived usefulness and security and privacy ($p < 0.05$). Besides, a reverse relationship was found between attitude

and personal demographic and personal experience ($p > 0.05$) (Table1).

Investigation of Research Hypotheses

In order to determine the desirability or otherwise of the physicians' attitude towards acceptance of smart phones, the mean scores were compared to 3 using sample t-test at 0.05 significance level. Considering the desirable measures of the indices and values of some important indices, the research model had appropriate fitness in the hospitals of Shiraz University of Medical Sciences (Table 2). The modified research model after omission of unaccepted relationships is presented in Figure 2.

In order to test the study hypotheses, SEM based on covariance which estimated the loads of statements and measurement errors with the related t was used, (Table 3). According to the value of R^2 at the bottom of the table, 66% of the changes in the physicians' attitude towards the acceptance of smart phones in the hospitals of Shiraz University of Medical Sciences were related to the factors confirmed in the table, while the remaining 40% included other effective factors that were not investigated in the present study.

Discussion

The results of the present study revealed the physicians' desirable attitude towards using smart phones ($p < 0.05$), which is in line with the results obtained by Spyglass Consulting Group in 2012 (15) and Manhattan's researchers in 2012 [16]. Such consistency among the results might be attributed to the popularity of this important functional device among users. Thus, measures can be taken towards wide utilization of this innovation in hospitals by appropriate planning and timing and preparation of conditions.

The study results also indicated that compatibility, observability, personal experience, voluntariness of use and perceived usefulness

Table 1: The correlation between attitude and other constructs

Construct	Regression (R ²)	Pearson (R)	p-value
Attitude	0.035	0.207	0.023
Observability			
Attitude	0.411	0.465	<0.01
Compatibility			
Attitude	0.184	0.437	<0.01
Job relevance			
Attitude	-0.005	0.058	0.52
Personal demographics			
Attitude	-0.008	0.025	0.79
Personal experience			
Attitude	0.123	0.361	<0.01
Internal environment			
Attitude	0.038	0.214	0.019
Voluntariness of use			
Attitude	0.228	0.484	<0.01
Perceived usefulness			
Attitude	0.047	0.235	0.010
Security and privacy			

were effective in the physicians’ attitude towards using smart phones.

The relationship between attitude and compatibility implies that compatibility affected the physicians’ attitude towards acceptance of smart phones. This result was in contrast to that

obtained by Park and Chen in 2007 [17], but in agreement with those obtained by Putzer in 2010 [12] and Kim and Ammeter in 2014 [10]. Hence, in case physicians see the superiority of this innovation compared to other technologies regarding compatibility with their jobs as well as the adaptability of smart phones with other technologies, such as Picture Archiving and Communication System (PACS) and other systems related to Health Information System (HIS) in hospitals, they will most probably use smart phones in their jobs. If health care organizations, including clinics and hospitals, aim to use this technology efficiently in the field of medicine, they have to make sure about its compatibility and security, and consider crisis management policies such as using passwords, for protecting information. They should also consider issues related to infrastructures such as bandwidth, used network and capability to build communication with other portable devices such as tablets, Personal Digital Assistant (PDA) and laptops through Bluetooth, WI-FI, etc.

The results of the present study revealed that attitude was associated with observability, indicating that observing the utilization of smart phones was effective in the physicians’ attitude. This result was in contrast to that of the study by Park and Chen in 2007 [17], but in line with that of the study by Putzer in 2010 [12]. Thus, observing other colleagues utilizing smart phones or observing a short period of using these devices experimentally can be influential in the acceptance of this new technology.

Table 2: The actual and recommended values of fit indices

Fit index	p-value	X ² /df	RMR	GFI	AGFI	NNFI	CFI	RMSEA
Recommended value	>0.05	<3	Closer to 0	Closer to 1	Closer to 1	>0.9	>0.9	<0.08
Actual value	0.26	1.35	0.07	0.77	0.71	0.93	0.94	0.054

Note: X²/df is the ratio between chi-square and degree of freedom; RMR is root mean square residual; GFI is goodness of fit index; AGFI is adjusted goodness of fit index; NNFI is non-normed fit index; CFI is comparative fit index; RMSEA is root mean square

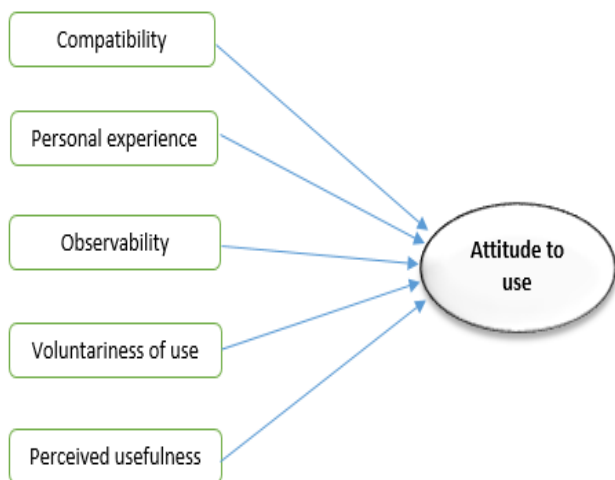


Figure 2: Approved conceptual model of the study

However, our study findings demonstrated no significant relationships between attitude and job relevance; this implies that the relevance of smart phones with medicine had no impact on the physicians’ attitude towards the acceptance of this technology. This result was not in agreement with those obtained by Park and Chen in 2007 [17] and Putzer in 2010 [12]. Rejection of this hypothesis can be attributed to the physicians’ low level of knowledge of the advantages of using smart phones in medicine. These advantages include having access to medical software and books, having access to reliable scientific journals and websites at any place and time, having access to patients’ laboratory results and medical records, making audio and video communications with other specialists, even those living far away, for information exchange, improving treatment quality, storing a vast volume of information and reducing medical errors [18].

The study results also showed no relationships between attitude and personal demographic, indicating that using smart phones by physicians was not associated with their age, sex and other personal characteristics. This result was consistent with that obtained by Putzer in 2010 [12], but not with that of the study performed by Van and Mad in 1987 [19].

On the other hand, the findings of the cur-

Table 3: The results of testing the research hypotheses

Construct	Hypotheses	Standardized solution	T-value	Remark
Attitude	H1	0.54	4.67	Supported
Observability				
Attitude	H2	0.17	2.53	Supported
Compatibility				
Attitude	H3	0.03	0.23	Not supported
Job relevance				
Attitude	H4	0.003	0.054	Not supported
Personal demographics				
Attitude	H5	0.16	3.15	Supported
Personal experience				
Attitude	H6	0.12	1.76	Not supported
Internal environment				
Attitude	H7	0.86	3.45	Supported
Voluntariness of use				
Attitude	H8	0.42	4.73	Supported
Perceived usefulness				
Attitude	H9	0.12	1.95	Not supported
Security and privacy				

R²=0.66

rent study confirmed the association between attitude and personal experience. This means that from the physicians’ perspective, experience of using smart phones was effective in their attitude towards the acceptance of this device. In other words, personal experience of using smart phones could increase the chance of acceptance of this technology among physicians. This finding was not consistent with those of the studies carried out by Van and

Mad in 1987 [19] and Putzer in 2010 [12]. The significant relationship between attitude and personal experience in our study might result from the young population under investigation, because smart phones now have a specific position in the lives of the youth.

The results of the present study showed no relationship between attitude and internal environment; this is in contrast to the results of the researches carried out by Park and Chen in 2007 [17], Putzer in 2010 [12], and Bhattacharjee in 2008 [19]. Nevertheless, the results revealed a significant relationship between attitude and voluntariness of use. This implies that the voluntariness of using smart phones had an impact on the physicians' attitude towards using this device. This result was not in agreement with that obtained by Mekic in 2014 [11]. Yet, it seems that the voluntariness of using any technology has a positive impact on attitude towards using it. In case this plan is implemented in hospitals, physicians might be allowed to use their own smart phones, because evidence has shown that users are more willing to use their own devices [20].

Our study findings also revealed that attitude was significantly associated with perceived usefulness; this means that simplicity and joyfulness of using smart phones were effective in the physicians' attitude towards the acceptance of this technology. This was in contrast to the result of the study by Mekic in 2014 [11], but in line with those obtained by Chtourou and Souiden in 2010 [21], Liao et al. in 2007 [22], and Jahangir et al. in 2008 [23].

Finally, our study findings indicated no relationship between attitude and security and privacy, which is in agreement with the results of the study by EnsarMekic in 2014 and in contrast to those obtained by Jahangir et al. in 2008 [23] and Rahmati et al. in 2013 [24]. Rejection of the relationship between attitude and security and privacy means that security and privacy of smart phones had no impact on the physicians' attitude towards using this technology.

Conclusion

Considering the fact that using smart phones in healthcare centers is increasing in developed countries. The findings of the present study showed that compatibility, observability, personal experience, voluntariness of use and perceived usefulness were effective in the physicians' attitude towards the acceptance of this technology. Since most of the physicians had desirable attitude towards the acceptance of smart phones in health and treatment due to their undeniable advantages, purposeful implementation of smart phones in hospitals is possible by elimination of barriers against using these devices supported by authorities and hospital managers. Overall, the findings of the current study can be used by policymakers, healthcare managers and researchers.

Acknowledgment

This article was extracted from an M.Sc. thesis written by Kazem Faghiri approved by Shiraz University of Medical Sciences (93-7319). Hereby, the authors would like to thank the dean and manager of Education and Research Vice-chancellors of the University. They are also grateful to managers, Education Vice-chancellors and physicians of the study hospitals for contributing their time to this study. The authors would like to thank Shiraz University of Medical Sciences, Shiraz, Iran and also Center for Development of Clinical Research of Namazi Hospital and Dr. Nasrin Shokrpour for editorial assistance.

Conflict of Interest

None

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