A comparison of physicians' and other health care professionals' perceived adoptions of smartphone

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Abstract

Portable devices such as the smartphone are transforming the healthcare industry. Our study explores the adoption behavior of health professionals in regional hospitals. This study employed a comparative design via questionnaire to investigate perception differences among 323 practitioners in US. Professionals were divided into four groups: physician, nurse, administrator, other professional. The results showed significant differences in several variables: attitude toward using a smartphone, observability, compatibility, personal demographics, and internal/ external environments. Adoption rates in large hospital settings approximated 70%; whereas, in smaller settings only 35%. The smartphone adoption in rural areas was less than metropolitan areas; yet, the advantages of using a smartphone for clinical tasks were well perceived. It appears a user's perception is significantly different between the groups.

Key words: Health care industry, smartphone, adoption, nurses, administrators, other health care professionals, comparison.

1. Introduction

Portable devices such as the smartphone are transforming the healthcare industry. The healthcare industry and health professionals have traditionally been slow to adopt new technologies. In 2009, Health Information Technology for Economic and Clinical Health (HITECH) Act promoted the adoption of electronic health record (EHR) system. Since then, 95 percent of hospitals were using EHR and approximately 76 percent of physicians were using electronic medical or health records (Health affairs, 2016). Likewise other information technology (HIT) platform, the smartphone is increasingly being adopted by the healthcare industry and clinicians (Ventola, 2014). According to Manhattan Research the number of physicians who use smartphones in their clinical works increased from 30 percent in 2013 to 40 percent in 2014 (Manhattan Research, 2014).

A few recent studies have shown that smartphones can improve workflow communication and productivity (Wu, Rossos, & Quan, 2011; Wu et al., 2015; Ventola, 2014; Patel et al., 2016). Online medical information technology company, Epocrates, concluded that more than 60 percent of physicians who used Epocrates at a hospital in Massachusetts presented a reduced likelihood of adverse drug events or medication errors (Epocrates, 2005). Epocrates also found that physicians who use their medical reference tools saved in pharmacy call-back times and information search while seeing patients. Moreover, many of the smartphone applications can improve productivity in many specialties of medicine. For instance, the mobile health applications on smartphones with respect to laboratory analysis (e.g., ARUP Consult and Care360) can provide expedient information regarding blood work and other physiological metrics. In the emergency department,

physicians can use the Vigilance application which will track vital signs of a patient, transmit live videos from exam and operating rooms and receive alerts when patients are distressed (Sarasohn-Kahn, 2010). Obstetricians can monitor patients remotely via the AirStrip OB iPhone application. This application improves productivity and care coordination by facilitating remote access to fetal heart tracings, contraction patterns, nursing notes and vital signs (Sarasohn-Kahn, 2010).

Smartphones also facilitate collaborative decision-making and telehealth communication through the use of radiological images and video streaming. At a recent radiology conference (the Radiological Society of North America), several papers showed the effectiveness of using smartphones in digital imaging applications (Choudri and Radvany, 2011). There are applications that assist radiologists with identifying the most appropriate radiological exam for a patient. A few recent studies have shown that smartphone-based exchange of radiological images (e.g., ultrasound, CT, and MR) in the fields of dermatology and surgery were helpful to support remote evaluation and clinical decision-making (Wu et al., 2015; Ebner et al., 2008).

To examine the adoption and acceptance of technological innovations, many studies embraced Technology Acceptance Model (TAM) and the Diffusion of Innovations (DOI) theory (Zhang, Yu, Yan, Ton, & Spil, 2015). These theories also have been applied to the research of mobile technologies. However, just a few studies have inspected innovation factors and the smartphone adoption in light of healthcare professionals in different groups. In this manner, we based TAM to

clarify health professionals' intentions and attitudes when they make clinical decisions using smartphone.

This study explored the adoption behavior of healthcare professionals when a smartphone can be utilized in their workplaces. Different groups of healthcare professionals perceive technology differently; thus, we divided them into distinct groups; physicians, nurses, administrators, and other professionals. An innovative gadget, mobile devices and the functional interface ought to fulfill the prerequisites of the capacities that the device is expected to bolster. In fact, the device's satisfying the task requirements in terms of efficiency and effectiveness regards as an essential feature. Consequently, in order to comprehend the factors motivating healthcare professionals' smartphone adoption, we adopted innovation factors based on TAM and DOI.

2. Literature Review

Many technology adoption papers applied TAM, one of the most popular theories, when dealing with user's acceptance and behavior. Davis created TAM in 1989 and this model examines the factors of user acceptance which clarifies a user's conduct as for the user's typical orientation with regard to the use of computing technologies (Davis, Bagozzi, & Warshaw, 1989). When it comes to real user experience, perceived ease of use and perceived usefulness have been identified as determining factors based on literatures. If the system is perceived as easy to use and useful, a user would have a positive attitude toward the system, which would facilitate the user's intention to use the system. Thus, the intention delivers an actual decision to use the system (Moon and Kim, 2001).

In order to examine group's adoption of innovating technology, DOI theory was best utilized among investigators (Zhang et al., 2015). Before adoption, an individual gathers information and investigates the technology how to improve the current status by learning and applying. To accept this technology, she eagers to test the technology in her actual workplace and see how it helps her activities. The theory also assumes that innovations factors would affect the individual's perception of the technology before the adoption (Fichman, 1992). Moreover, these factors can make the adoption faster. Therefore, we adopted them as the attributes of our research model. Because smartphone was introduced fairly recently, we treat it as an innovation.

TAM was applied to specifically examine attitude and behavioral intention to use a smartphone with seven pertinent innovation factors: compatibility, observability, job relevance, personal demographics, personal experience, the internal environment and the external environment. We hypothesize that innovation factors are associated with attitude toward using a smartphone and attitude is associated with behavioral intention to use.

Summary of Research Variables

Variable	**Number of Items**
Behavioral Intention to Use (BVINT)	4
Attitude toward using (ATT)	4
Observability (OBSER)	2
Comparability (COMP)	3
Job relevance (JOB)	3
Personal demographics (PDEM)	3
Personal experience (PEXP)	2
Internal environment (INTNV)	4
External environment (EXTNV)	3

Table 1: questionnaire items

3. Methods

This study followed a comparative design to investigate perception differences among various health care practitioners. More specifically, to test the differences, a non-parametric test was applied due to its free of distribution assumption. Afterwards, ordinal regression was completed to show the relationships of the constructs. The study sample consisted of health professionals, conveniently selected from healthcare organizations in the Southeastern and Midwestern in United States. These local and regional hospitals served larger areas with more complex and specialty cares. Thus, each hospital strategically operated in cities and other counties as well.

A questionnaire was developed and it was principally derived from previous studies. The items of behavioral intention and attitude toward using smartphone were derived from the technology acceptance model (Chau & Hu, 1996; Venkatesh & Davis, 1996). The remaining constructs were drawn from the diffusion of innovation theory (Wu and Wu, 2005). The constructs are behavioral intention to Use (BVINT), attitude toward using (ATT), observability (OBSER), comparability (COMP), job relevance (JOB), personal demographics (PDEM), personal experience (PEXP), internal environment (INTNV), and external environment (EXTNV). Table 1 summarizes the variables and questionnaire items. Each variable was measured with several questions. This study used a five-point Likert scale ranging from “strongly disagree” to “strongly agree”. We added demographic questions at the end of the questionnaire so that subjects can be divided subsamples.

4. Results

After our research was approved from each institution's IRB, a total of 600 subjects were identified and asked to participate in the study. A mailing list was maintained with confidentiality and void of personal data. After data collection, we quickly analyzed the means and checked for normal distribution. When the data was not normally distributed, a nonparametric approach was used. Chi-square was used to test significant differences among the variables. Kruskal-Wallis test was also utilized to compare the differences among multiple groups on an ordinal variable.

Questionnaires were returned from 323 participants, a response rate of 53.8%. Respondents comprised of 52.8% of men and 47.2% of women. Among respondents, 52.3% were physicians; 22.9% were nurses; 5.6% were administrators; 13.9% were other professionals; 5.3% with no response. In terms of working experience for physicians (77 answered) , only 4 physicians had less than 5 years of experience; 23 physicians had at least 15 years of experience; 50 physicians had more than 20 years of experience. For nurses' working experience, 14 nurses had less than 5 years of experience; 26 nurses had at least 15 years of experience; 32 nurses had more than 20 years of experience. The complete results of this analysis of respondents are presented in Tables 2-3.

	Frequency	Percent	Valid Percent	Cumulative Percent
Physician	169	52.3	55.2	55.2
Nurse	74	22.9	24.2	79.4
Administrator	18	5.6	5.9	85.3
Other Health Professionals	45	13.9	14.7	100.0
Subtotal	306	94.7	100.0	
Missing System	17	5.3		
Total	323	100.0		

Table 2: Health Professional Job title

		Job title				
		Physician	Nurse	Administrator	Other	Total
Gender	Male	125	6	12	18	161
	Female	43	68	6	27	144
Total		168	74	18	45	305

Table 3: Gender by Job title

As shown Table 4, there was no significant difference on the perception of Behavioral Intention to Use between the four groups. Attitude toward using a smartphone in the workplace showed a significant difference between the four groups: mean scores of 3.44, 3.65, 3.66, and 3.29 respectively ($p < .001$). Observability in the workplace showed a significant difference between the four groups: mean scores of 2.49, 2.41, 3.04, and 2.05 respectively ($p < .005$). Compatibility also showed a significant difference between the four groups: mean scores of 3.48, 3.75, 3.81 and 3.09 respectively ($p < .001$). In Job relevance, there was no significant difference between the four groups: mean scores of 3.39, 3.38, 3.53, and 3.57 respectively ($p < .586$). Personal demographics found a significant difference between the four groups: mean scores of 3.10, 2.41, 3.13, and 3.25 respectively ($p < .000$). In Personal experience, there was no significant difference between the four groups: mean scores of 3.57, 3.72, 3.72, and 3.55 respectively ($p < .282$). A significant difference was found regarding the Internal environment between the four groups: mean scores of 3.68, 4.05, 4.05, and 3.75 respectively ($p < .000$). A significant difference also was found regarding the External environment between the four groups: mean scores of 3.63, 3.97, 3.77, and 3.70 respectively ($p < .001$).

In regard to attitude toward using a smartphone affecting behavioral intention to use, the ordinal regression results showed a positive relationship with x^2 =448.88 and p=.000. To examine the influence of attitude toward using a smartphone

on observability, compatibility, job relevance, personal demographics, personal experience, the internal environment, and the external environment, another ordinal regression was performed. The results indicated a significant relationship (x^2 = 359.63, p=.001)

Perceptions of healthcare practitioners on smartphone use in workplace

Variable	Number of Items	Physicians Mean score	Nurses Mean score	Administrators Mean score	Other Mean score	p-value[a]
Behavioral Intention to Use (BVINT)	4	3.99	3.99	4.10	3.88	.292
Attitude toward using (ATT)	4	3.44	3.65	3.66	3.29	.001
Observability (OBSER)	2	2.49	2.41	3.04	2.05	.005
Comparability (COMP)	3	3.48	3.75	3.81	3.09	.001
Job relevance (JOB)	3	3.39	3.38	3.53	3.57	.586
Personal demographics (PDEM)	3	3.10	2.41	3.13	3.25	.000
Personal experience (PEXP)	2	3.57	3.72	3.72	3.55	.282
Internal environment (INTNV)	4	3.68	4.05	4.05	3.75	.000
External environment (EXTNV)	2	3.63	3.97	3.77	3.70	.001

Table 4: [a] Kruskal Wallis Test

Regression analysis

Chi-Square	df	Sig.
448.888	17	.000

Table 5: Behavioral intention on Attitude

Regression analysis

Chi-Square	df	Sig.
359.632	101	.001

Table 6: Attitude on observability, compatibility, job relevance, personal demographics, personal experience, the internal environment, and the external environment

5. Discussion

Although physician adoption rates of smartphone in large hospital settings reached up 70%, the rate in smaller hospitals only reached 35%. In order to find the reasons behind the low adoption rate in the rural areas, we theorized that user's perception of innovate technology may impact the adoption behavior based on TAM and DOI. We also stipulate that user's perception is significantly different between physicians, nurses, administrators, and other professionals.

The results indicated that there was no significant difference on the perception of behavioral Intention to use between the four groups. The data also showed attitude toward using smartphone leads to behavioral intention to use. This confirms previous study results. Observability in the workplace showed a significant difference between the four groups. Pre exposing an individual to a smartphone dramatically alters an individual's perception before adopting it. Pre-trial at the workplace is another positive factor for a user to approve a smartphone. Compatibility also showed a significant difference between the four groups. When healthcare providers viewed smartphones as having broad compatibility with other technologies in the hospital, their attitude toward using a smartphone tends to be positive.

However, job relevance did not show a significant difference between the four groups. We also found that personal demographics showed a significant difference between the four groups. Personal experience also showed no difference between the four groups. This means previous experience such as, computer works would not be recognized as a significant factor. Internal environment indicated a significant difference between the four groups. This is consistent with results from a previous study. Internal environment has been known to have organizational scale, management support for information technology, and organization learning culture.

6. Conclusions

The healthcare industry can prosper from this study regarding the implications of innovation factors. The perception of innovation factors from various groups of healthcare professionals agreed with the results of previous studies. It is believed that mobile devices can fundamentally change how healthcare is delivered. Although the smartphone adoption in rural areas is not high as in metropolitan areas, the advantages of using it in clinical tasks are well perceived by healthcare professionals. Therefore, if our findings about innovation factors and user's attitude are well understood, the implementation of innovation technology can go smoothly.

Although this study delivered insights into the perception of innovate factors on smartphone use, limitations do exist. Our findings were achieved from a single study. Therefore, we must exercise caution when generalizing the results. Additionally, future study can focus on each healthcare professional group by analyzing what and how the factors cause the adoption and utilization of smartphones in clinical tasks.

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