MEDINFO 2010
C. Safran et al. (Eds.)
IOS Press, 2010

doi:10.3233/978-1-60750-588-4-342

Key Common Determinants for Adoption of Wireless Technology in Healthcare for India and Pakistan: Development of a conceptual model

Abdul Hafeez-Baig and Raj Gururajan

School of Information Systems, University of Southern Queensland, Toowoomba, Australia 4350

Abstract

This study explores the perception and views of healthcare professionals in the subcontinent (India and Pakistan) towards the wireless handheld technology in the healthcare setting. A mixed methodology was adopted to explore the determinants of the wireless handheld devices in the healthcare setting. Interviews were conducted with 30 healthcare professionals to explore the initial themes. This was followed up with a survey instrument, specifically developed for this study, and distributed to 300 healthcare professionals in Pakistan and India. 200 useable surveys from India and 97 from Pakistan were received. The results of the study indicate that healthcare professionals felt that to use the wireless technology, the integration of the clinical and operational process is essential. Factor analysis through SPSS showed that any development of technological solutions for handheld devices would benefit, by considering the clinical, technological, and operational influences of the wireless technology in addition to clinical influences, clinical preference, training, and technical support. The study culminated in the development of an initial conceptual framework. The scope of this study is restricted to wireless handheld devices such as the smart phones, handheld PCs and PDAs.

Keywords:

Wireless technology, Healthcare, PDA's, Handheld

Introduction

Technology Acceptance Model (TAM) asserted 'perceived ease of use' and 'perceived usefulness' as the determinants in predicting the acceptance of technology in a given setting. These constructs were found reliable in many Information Systems studies. However, when these models were tested in a healthcare environment, the perceived ease of use was not found to be significant [1, 2]. Furthermore, other studies also established that the perceived ease of use was not a significant predictor of technology acceptance in specific clinical domains [3, 4]; Hu et al., [5]. While studying the dynamics of IT adoption in a major change process in health delivery, TAM was found inadequate [6]. In introducing electronic patient records into hospitals, it was found that relative advantages, available strong network externalities, and the rich availability of information through different communication channels influenced technology adoption [7]. While measuring the physician's understanding of online systems use, the physicians' behaviour, their workflow practices and their perceptions regarding the value of specific information systems were found to be more significant than the perceived ease of use and perceived usefulness [8]. Therefore, there is a need to revisit the factors that determine the adoption of wireless technology in healthcare.

Research Problem/Design

Literature identified various factors that can influence the acceptance/usage of wireless handheld devices in the healthcare environment. For example, mobility, real time access, reduction in cost, improved patient care, and reduction in error [9-14] are factors identified using wireless technology in terms of improving healthcare. There are limited studies that have investigated the views and opinions of healthcare professionals in terms of wireless handheld devices in the Indian and Pakistani healthcare environment. In order to identify themes that may be applicable to the Indian and Pakistani environment, we conducted a set of 30 interviews in the Indian healthcare environment. We omitted Pakistan from the interviews as the two countries come with similar healthcare settings and it was convenient for the interviews to be conducted in India. Participants for the interviews were selected from private and public hospitals that were involved with patient care and had some exposure to wireless technology. In order to ensure the interviews were conducted on time, the local health district was approached by an author of this paper and suitable candidate groups were identified. The interviews were conducted in such a fashion as to minimize any disruption to the participants' work schedule, to ensure comfort in answering questions, to minimize any travel time by interviewees, to synchronize the 'interview' language with participants and to prompt participants when unknown aspects were encountered by participants. Prior to the interviews, the line managers were approached for permission to release staff for the interviews. Initially a consent letter was distributed to obtain consent for interviews and the list of people to be interviewed was provided to the Health District. The interviews were recorded using a digital recorder and

catalogued as per the ethical requirements. These interviews were then transcribed for data analysis. Participants for the interview were selected from the healthcare professionals in the Southern Region of India. The participants were initially screened for suitability, and previous workings with technology were considered for this purpose. Any staff involved with 'administration only' was eliminated from the interviews to avoid any unforeseen bias. As the healthcare professionals belonged to the Health Department, no further screening was employed for the sampling.

The instruments of this research consisted of two broad categories of questions. The first category of questions was related to the adoption and usage of wireless devices in hospitals for data collection purposes. In this category, questions were asked in terms of usage, perceived benefits, perceived problems, management issues, performance issues and operational aspects. The second category consisted of demographic variables. Open-ended questions were included in the instrument to obtain unbiased and non-leading information. Prior to administering the questions, a complete peer review and a pilot study were conducted in order to ascertain the validity of the instruments. The specific research problem investigated during this stage of the study is as follows

- What are the factors of acceptance of wireless technology in a healthcare environment for India and Pakistan?
- What are the emerging challenges in adopting wireless handheld devices for the Indian and Pakistani healthcare environments?

Survey Data Collection

In order to extract opinions about technology in a specific domain such as healthcare, the choice of sample is crucial. This is because the opinions expressed by healthcare professionals should be unbiased and should pertain only to the technology and not the effects of the technology on their current workflow. The samples for this project were drawn from the health department of both Pakistan and India, where each participant is currently holding a practicing license. Furthermore, the participants chosen were working in clinical wards. People in administrative roles were eliminated from this stage to avoid any unforeseen bias. While Information Systems research identifies a range of sampling techniques such as random and clustering, the sampling technique used for this study was 'purposive' sampling. As healthcare staff with special knowledge of technology were needed, this sampling technique was employed in this study. The samples were chosen through the local medical district on their advice as their opinions on wireless technology were extracted based on their knowledge. Therefore, the samples needed to exhibit certain attributes that are related to technology adoption.

This study developed a specific survey instrument from the interview data. The main reason for this approach was that previously tested instruments were found to be inadequate in the healthcare settings of Pakistan and India. The data from the interviews was used to develop a specific range of questions to gather a more detailed view from the wider population, such as the usefulness of wireless handheld devices in healthcare, participants' knowledge of wireless handheld technology, their views about error reduction and cost reduction, and the clinical efficiency as well as performance factors. This survey instrument (contains 5 point likert scale) was pilot tested to capture the information reflecting the perceptions and practice of those adopting the wireless technology in the Pakistani and Indian healthcare system, particularly focused on what internal and external environmental factors shape the adoption of wireless and the extent of influence.

This survey was then randomly distributed to over 300 healthcare professionals from the Southern Region of India, and in the Punjab province of Pakistan. A cover letter explained the objectives and goals of the research. In order to improve the response rate a telephone reminder was sent two weeks after the initial date of survey distribution. A total of 200 surveys were received from India and 97 were received from Pakistan. When the instrument was tested for reliability, the Cronbach Alpha was over 0.89, confirming reliability. Table 1 provides a summary of the demographics. It can be inferred from the table below that for the Pakistan sample, there was an equal number of males and females, and the median experience was less than 10 years, as most of them had a bachelor's qualification, and many of them were under 25 years of age. The demographics for the Indian sample were inconclusive as many participants did not fill in this information.

Table 1- Summary of demographic data

Category	Descriptions	Pakistani	India
Gender	Male	50.5%	70%
	Female	49.5%	30%
Education	Bachelor degree	73.2%	50%
	Diploma/Certificate	4.1%	16%
	Other	10%	15.5%
Experience	Less than 2 years	17%	27.5%
	Less than 10 years	69%	51.0%
	More than 10 years	11%	20.5%
Age	Less than 23	52.6%	40.9%
	Between 23 and 29	26.8%	17.0%
	Between 30 and 36	10.3%	5.5%

Once the instrument was found to be suitable, a factor analysis as "Principal Component Analysis" with "Varimax Rotation" was run on the data. Results of the factor analysis for the Indian sector are shown in Table 2, below.

Table 2- Results of factor analysis on the Indian survey data

Indian Data	Component		
	CP	CM	TB
Reduce-workload	.651		
Improve-public-image	.684		
Improve-clinical-	.695		
Attract-more-practitioners	.596		
Save-time	.762		
More-training	.706		
Save-effort	.754		
Tech-support	.769		
Reduce-overall-cost	.633		

Table 2 (continued)

Indian Data	Component		
	CP	CM	TB
Reduce-medical-errors	.644		
More-contact-time-with-	.721		
Improve-clinical-workflow	.801		
Efficiency-in-communication	.728		
Better-quality-of-service	.747		
Improved-delivery-of-	.740		
Delivery-of-high-qual-info	.762		
Reduce-inaccuracies	.659		
Easy-access-to-data	.692		
Positive-impact-on-patient-	.686		
Time for training barrier			.518
Poor technology barrier			.656
Legal barriers			.538
Tech expertise barrier			.710
Technical support barrier			.597
39-Medical database referral		.655	
Daily scheduling of		.661	
Obtain lab results		.611	
Billing and accounting		.621	
Disease state management		.610	
Administrative purpose		.686	
Note taking		.738	
Drug administration		.629	
Communication with		.647	

CP = Clinical Performances, CM = clinical management, and TB = Technology Barrier

The Indian data returned three factor groupings. These factors were titled clinical performance, clinical management, and technology barrier. Similarly, the factor analysis as "Principal Component Analysis" with "Varimax Rotation" was run for the Pakistan data and resulted in three specific factors, namely data management, clinical performance and usage barrier as is shown in Table 3. As a result of factor analysis, the initial framework did not distinguish among positive and negative factors and did not incorporate the mediating factors either, as this was not the scope of this paper.

Table 3- Results of factor analysis on the Pakistan survey data

Pakistani Data	**Component**		
	DM	**CP**	**UB**
Reduce-workload		.673	
Improve-clinical-performance		.716	
Attract-more-practitioners		.607	
Save-time		.548	
Save-effort		.604	
Tech-support		.523	
Reduce-medical-errors		.580	
Improve-clinical-workflow		.695	
Efficiency-in-communication		.672	
Better-quality-of-service		.738	
Improved-delivery-of-		.640	
Delivery-of-high-qual-info		.654	
Reduce-inaccuracies		.668	
Easy-access-to-data		.667	
Positive-impact-on-patient-		.714	
Resource barrier			.507
Tech expertise barrier			.565
Device usage barrier			.561
Device comfort barrier			.538
Generating exception list	.804		

Table 3 (continued)

Pakistani Data	**Component**		
	DM	**CP**	**UB**
Patient education	.608		
Drug administration	.618		
Communication with	.670		
Communication with	.569		
Communication with patients	.598		
Electronic medical records	.785		
Medical database referral	.816		
Electronic prescribing	.783		
Daily scheduling of	.591		
Obtain lab results	.776		
Billing and accounting	.697		
Disease state management	.717		

DM = Data Management, CP = Clinical Performance, and UB = Usage Barrier

Combined Pakistan and India Data Analysis

We also conducted an exploratory factor analysis to investigate the combined data. The combined data resulted in four distinct factors, namely clinical performance, clinical data management, technology barriers, and clinical communication. When a correlation analysis was conducted, most of the factors correlated with their group items positively and significantly, indicating the cohesive nature of these groupings. As the nature of the study is exploratory, once the data reduction technique was adopted, the factor analysis was saved as component factors with the following labels: Clinical Performance (CP), Clinical Data Management (CDM), Technology Management (TM), Clinical Communications (CC) and the predictor variable Intention to use (ITU). The strategy was to combine related items of the factor analysis into a single item. Further before conducting the regression analysis, a correlation analysis was conducted among the independent variables CP, CDM, TM, CC, and the predictor variable ITU.

As can been seen from Table 4, the correlation analysis shows a low correlation among the independent variables. The correlation between the composite variable is positive and is not significant ($r < .5$ and $p < .05$), where as the correlation for the composite variable technology management and the predictor ITU is low with a negative direction ($r < .5$ and $p < .05$). Therefore, multicollinearity does not exist for the composite variables, and according to [15] multicollinearity exists only if there is a strong correlation between the independent variables (as $r < .5$).

Table 4- Summary of correlation (2-tailed) analysis

	ITU	CP	CDM	TM	CC
Intention to Use	1.000	.791**	-.030	-.285**	.087
Clinical Performance	.791**	1.000	.000	.000	.000
Clinical Data	-.030	.000	1.000	.000	.000
Technology	-.285**	.000	.000	1.000	.000
Clinical	.087	.000	.000	.000	1.000

To understand the role of each composite variable and to explain the variation in the predictor a regression analysis was conducted. The linear regression analysis was conducted as the "Enter" method with ITU as the dependent variable and CP, CDM, TM, and CC as dependent variables to understand the variation in the ITU. The 61.2 % variation in the ITU is explained by the predictors CP, CDM, TM, and CC ($R = .786$ and Adjusted R-Square is .612). From the regression analysis, independent variables "Clinical performance", "Technology management", and "Clinical Communications" for the subcontinent healthcare professionals are quite significant and uniquely contribute to their views about uses of wireless handheld devices in a healthcare setting ($\beta = .74$, $t = 20.3$, $p < .05$, and $\beta = .08$, $t = 2.2$, $p < .05$). Whereas the independent variable "Clinical data management" seems to not be providing any unique contribution in explaining the healthcare professional intention to use wireless handheld devices in the sub-continental healthcare environment ($\beta = -.03$, $t = -.8$, $p > .05$). Once it was clear that the independent variable CDM was not contributing to explaining the variation in ITU wireless handheld devices, another linear regression without the CDM variable was conducted and the regression results were not much different from the previous analysis ($R = .79$, Adjusted R-Square = .613, df (293,3) = 157, $p < .05$ and $\beta = .74$, $t = 20.3$, $p < .05$, and $\beta = .08$, $t = 2.2$, $p < .05$). The standardized coefficient of multiple regression analysis provided the relationship of the independent variables (CP, CDM, TM, and TM) for the dependent variable of intention to use wireless handheld devices for the subcontinent's healthcare environment.

The above framework shows the relationship between the dependent and independent variables, the analysis shows that healthcare professionals in the subcontinent see variables such as "clinical performance" and "clinical communications" as having a positive effect on the intention to use the wireless handheld devices in the healthcare setting.

Discussion

The data analyses indicated that clinical performance and clinical data management are common to both countries. However, as can been seen, both countries have concerns about the barriers. Indian healthcare professional perceived the existing status of the wireless handheld technology itself posing some barriers, whereas, Pakistani healthcare professionals perceived the barriers in terms of usage context. In the combined context, communication is an additional factor contributing to the usefulness of wireless technology in healthcare. The combined data clearly indicates the clinical performance, clinical data management and technology barriers to realize the usefulness of wireless technology in a healthcare domain as the three main contributors of acceptance of wireless technology. This indicates that in order to be accepted, technology should be useful in a given context. In terms of clinical performance, the factors such as reduced workload [8], the saving of time [16], the reduced overall cost [17], the reduced medical errors [18], the reduced inaccuracies [19] and the easy access to data [20] have already been identified in the literature. This study has confirmed these factors, perhaps for the first time, using empirical evidence. However, factors such as improved public image and improved clinical performance attract more practitioners, more contact time with patients, better quality of service and the delivery of high quality information are new factors. The set of these factors indicate that medical staffs perceive the wireless technology to provide direct benefits in these areas in order to realize better clinical performance. These respondents have also identified the positive-impact-on-patient-safety in addition to the above factors, subtly indicating their concern on patient safety due to the current inferior standards of data quality. These factors are new and have not yet been established in the literature.

In terms of technology barriers, this study established system migration, benefit evaluation, time for training, poor technology, incomplete health standards, legal, technical expertise, technical support, security, device usage, device comfort and device access as barriers to the clinical usefulness of wireless technology. While some of the factors such as the poor technology have been identified in the literature, the device access and device usage aspects are surprising. One would expect that due to the relative affordable cost of the devices, access and usage would be drivers rather than barriers. The views expressed by the respondents indicate this not to be the case. This may be due to the fact that the current health system budgets are predominantly allocated to salaries and clinical services rather than investment in technology. One would expect that by investing in technology and the prevalence of telemedicine concept, it would be possible to reduce the queues in hospitals. This does not appear to be the case. The third set of factors, clinical data management, is interesting because for the first time certain specific factors were identified to highlight the usefulness of wireless technology for healthcare. These factors include medical database referral, electronic prescribing, obtaining lab results, note taking, and drug administration. While previous studies have highlighted the usefulness of wireless technology, most of them have focused on the management aspects, clinical usefulness was very seldom covered in the literature. This study has identified specific factors that contribute to the usefulness of wireless technology in a clinical setting. In addition to identifying these factors, this study was able to identify the common factors between two radically different medical systems, namely India and Pakistan. Despite the relative differences between the countries, this study has been able to establish a set of common factors that bind the clinical usefulness factors of wireless technology for these two healthcare systems.

Conclusion

It can be concluded from this study that technical, clinical and management/operational factors are the driving force behind the intention of the healthcare professional to use the wireless handheld technology in the subcontinent.

It can be also be summarized that drivers are the factors with the potential of improving the clinical process and

management of the patient care, and the inhibitors are due to lack of wireless solution, infant stages of the technology, and management support. There is clear evidence that healthcare professionals in the subcontinent are motivated and keen to use the wireless handheld technology in the healthcare environment. This study has identified factors such as clinical performance, clinical management, clinical communication, and data management as major factors for the intention to use wireless handheld devices. The main challenge that has emerged from this study is that even though healthcare professionals are motivated, they would like to see the usefulness of the technology and availability of the appropriate healthcare applications for wireless handheld devices.

Future studies can use these factors in order to develop a regression model so that the factors identified can be regressed into a smaller set. The main purpose of the study was to identify initial factors and hence the data collected was not found to be suitable for a second order regression model. Therefore, this was not attempted in this study.

References

[1] Chismar WR and Wiley-Patton S, "Predicting Internet Use: Applying teh Extended Technology Acceptance Model to the Healthcare Environment," in E-Health Systems Diffusion and USe: The Innovation, the USer and the USE IT Model, T. A. M. Spil and R. W. Schuring, Eds. London: Idea Group PUblishing, 2006.

[2] Spil TAM and Schuring RW, E-Health system Diffusion and Use. Hershey: IDea Group Publishing, 2006.

[3] Jayasuriya R, "Determinants of microcomputer technology use: Implications for education and training of health staff," International Journal of Medical Informatics, vol. 50, pp. 187-194, 1998.

[4] Chau PYK and Hu PJH, "Investigating healthcare professionals' decision to accept telemedicine technology: An empirical test of competing theories," Information and Management, vol. 39, pp. 297-311, 2002.

[5] Hu PJ, Chau PYK, and Tam KY, "Examining teh technologya cceptance model using physician acceptance of telemedicine technology," Journal of Management Information Systems, vol. 16, pp. 91-112, 1999.

[6] Lapointe L, Lamothe L, and Fortin J, "The dynamics of IT adoption in a major change process in healthcare delivery," in E-Health Systems Diffusion and Use: The Innovation, the User and the USE IT Model, T. A. M. Spil and R. W. Schuring, Eds. London: The Idea Group Publishing, 2006.

[7] Suomi R, "Introducing electronic patient records to hospitals: Innovation adoption paths," in E-Health Systems Diffusion and Use: The Innovation, the User and the USE IT Model, T. A. M. Spil and R. W.Schuring, Eds. London: Idea Group Publishing, 2006.

[8] Horan TA, Tule B, and Hilton BN, "Understanding physician use of online systems: An empirical assessment of an electronic disability evaluation system," in E-Health Systems Diffusion and Use: The Innovation, the User and the USE IT Model, T. A. M. Spil and R. W.Schuring, Eds. London: Idea Group Publishing, 2006.

[9] Smithline N, "Handhelds, the holy grail of health care?," in Poceedings of annual HIMSS Conference, 2002.

[10] Rosenberg M and Krajekian J, "Personal digital assistants: an asset to managing healthcare," Journal of the Massachusetts Dental Society, vol. 49, pp. 32-35, 2001.

[11] Williams B, "Handheld computers making the rounds with physicians. Devices put medical know-how-literally--in the palm of your hand," vol. 94, pp. 30-31, 2001.

[12] Lu YC, Xiao Y, Sears A, and Jacko J, "A review and a framework of handheld computer adoption in healthcare," International Journal of Medical Informatics, vol. 74, pp. 409-422, 2005.

[13] Wilcox RA and Whitham EM, "Reduction of medical error at the point-of-care using electronic clinical information delivery," Internal Medicine Journal, vol. 33, pp. 537-540, 2003.

[14] Spigel S, "Information Technology And Medical Error ", 2004.

[15] Hair JF, Black WC, Babin BJ, Anderson RE, and Tatham RL, Multivariate data analysis, 6th ed. Upper Saddle River, NJ: Pearson Education Inc., 2006.

[16] Rogoski R, "Wireless by Design," Health Management Technology, pp. 1-7, 2005.

[17] Caffery L and Manthey K, "Automatic message handling for a national counselling service," in Success and failure in telehealth, Brisbane, Australia, 2004.

[18] Crow A, "Defining the balance for now and the future - Clinicians perspective of implementing a care coordination information systems management," in HIC 2004, Brisbane, Australia, 2004.

[19] Hailey D, Ohinmaa A, and Roine R, "Published evidence on the success of telecardiology: a mixed record," in Success and failures in telehealth, Brisbane, Australia, 2004.

[20] Gururajan R, "A Study of the use of Hand-Held Devices in an Emergency Department," Journal of Telehealth, vol. 1, pp. 31-34, 2004.

Address for correspondence:

abdulhb@usq.du.au