Views of Healthcare Professionals on Factors Influencing Clinical Performance for Use of Wireless Technology in Australian Healthcare Environment

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ABSTRACT

Prior studies agree that wireless applications have the potential to address the endemic problems of healthcare, limited information can be found about the determinants. There is a need to identify factors that assist in the adoption of wireless applications in healthcare. The first phase of the study was involving semi structured interview approach with selected healthcare professionals to understand various factors involved in the adoption of wireless applications, second phase involved administering a survey to generalize the finding of first phase and capture the views of the wider population. Initial finding of the study have been presented in this paper.

Keywords: Wireless technology, Healthcare, Adoption factors, Information Systems

1. Introduction

Last three decades of investment in the information and communication technology have had dynamic effects on healthcare. Such an investment has resulted increased in productivity, high quality of services and development of new processes. Despite this, healthcare industry did not enjoy the flexibility as the industry was always operating under limited resources. Recently, the strategists, operators, decision makers, and other stake holders have realize the potential of information communication technology (ICT), especially in wireless technology and see an opportunity window to address some issues healthcare sector is facing. It is suggested the ICT have the potential to address the issues such as quality of care, reduction in cost, shortages of human resources, reduction in errors, reduction in funding, and high satisfaction levels among customers and employees. For example, a patient registering in a hospital may be issued with electronically readable code and staff with wireless devices can enter critical information directly into the hospital network. Trough wireless devices, patient body can be connected to various hospital equipments to record medical data, such as blood pressure, heart function can directly be monitor, recorded, and analyzed by doctors internally and externally. Trough wireless network, doctor can order tests, prescribe medicines, and request for other services directly from the patient bed.

Australian healthcare industry is operating under the umbrella of high expectation, reduce funding, aging population, pressure from industry regulatory bodies, pressure to integrate new technological development in the exiting business processes, and ability to provide customized care and other associated activities, wherever, whenever, with a competitive cost, at the point of care in a highly competitive environment. Under such a circumstance healthcare provider are operating with limited resources, reduction in operating cost, and demands to redesign their workflow systems, to accommodate the dynamic environment of

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healthcare industry. Therefore, adoption and utilization of new technological developments is very critical for survival of healthcare in Australia. It seems due to the reduction in hardware/operating costs, functionality, and ability to transmit high speed secure data wireless technologies are able to address most of the concerned of the healthcare provider.

2. Literature Review

In healthcare literature, the concept of wireless technology1 is discussed by many studies (Wisnicki, 2002, Dyer, 2003, Simpson, 2003, Sausser, 2003, Handy et al., 2002). For example, Wisnicki (Baker) provides details of how broadband technology, a component of wireless technology, can be used in healthcare. The discussion provided by (Wisnicki, 2002) involves the high cost of setting up a wireless technology in a healthcare setting, improvements to patient care using this technology and potential cost-effective quality of service to patients. Sausser (2003) provides information on how to improve clinical quality using wireless technology including challenges for maintaining security and privacy. Sausser (2003) also discusses the concept of portable devices for data collection purposes by providing an argument on benefits that can be realized using these devices. (Simpson, 2003) while critiquing the nursing domain stresses the need for the innovative use of IT to improve patient care. He points out that new wireless technologies can help to address some of the chronic problems encountered including saving nurses' time, skilled nursing care and home healthcare. (Dyer, 2003) on the other hand, provides details of how text messaging using wireless devices can be effectively used to remind patients of their appointments. He reports the idea behind a radically new system of managing patient care in conjunction with modern telecommunication applications using wireless devices to improve the quality of patient care. Common to all these studies is the use of emerging wireless applications in healthcare and potential benefits that can be achieved.

While many other studies in the healthcare literature echo similar sentiments, none of these studies have examined the potential challenges of using wireless applications. It appears that almost all studies have taken this crucial aspect for granted and did not research, for example, the impact of factors such as compatibility, integration, support and training, configuration, and security issues. While some studies have indicated existing problems in collecting patient data and provided some theoretical solutions, these studies have seldom analyzed the changing nature of information systems using wireless applications. For instance, (Sausser, 2003) mentions the advantages of using mobile technology in collecting patient data, but does not provide an in-depth analysis of the strengths, weaknesses, their influences and how critical these factors are for successful implementation and usage of wireless technology.

To comprehend the issues related with data collection using wireless applications, information technology studies were also reviewed. The review indicated that this area (wireless technology) is not fully researched in information systems. For example, (Redman, 2002) states that the wireless technology is in its infancy stage and warns of the potential pitfalls if IT providers rushing to implement the technology, (Shah, 2001) warns of the slower speed of wireless networks compared with the desktop computers and highlights the potential problems that could be encountered by healthcare. The relatively high costs to set up initially these wireless networks is mentioned by (Shroefer, 1999). The lack of real time connectivity due to the mobility of the device and the problems associated with such mobility is highlighted by (Stevenson, 2001). The size of the screen and hence the problems that may be encountered in displaying data due to screen size while capturing data is stressed by (Toms, 2000). The problems that may be encountered due to the lack of provision for high quality graphic display on wireless devices is highlighted by (Atwal, 2001). (Bevan and Mittman, 2002) discusses the potential problems of capturing data using wireless devices due to the 'hard-to-see display' nature of these devices. While the studies mentioned above warn of the problems that could be encountered while using wireless applications, they also tend to agree that the usage capabilities of these wireless applications are growing and hence these hardware related problems will disappear in a few years time.

What can be realized from this review is that the bulk of the studies have paid attention on the 'hardware' or 'physical' component of wireless devices, as this appears to be a focal point of interest to many authors now. Other studies refer to the 'implementation' or 'management' of these wireless technologies in healthcare organizations, as cost appears to be a determining factor in such implementations. None of the studies appear to have examined the 'usage' aspects of wireless applications. Consequently the overreaching aim of this study is to explore and identify the drivers and inhibitors for adoption of wireless applications in the healthcare industry for data management. Therefore research question addresses in this study is as follow:

Research Question-1: What factors influence the uptake of wireless applications in healthcare environment?

3. Research Design[2]

The research design of this study involves both qualitative and quantitative techniques. The qualitative techniques were employed to get 'first hand' information from nurses using a semi structured interview approach. This is essential because the literature is limited in this aspect. The quantitative method involved developing a survey instrument to obtain nurses' perceived opinion on various factors impacting the adoption of wireless technology, as found from the interviews. The data were collected in two stages that are six months apart. In the first stage, data were collected from nursing staff involved in patient care about their adoption and usage behavior of data collection using current technologies. In the second phase, respondents were contacted again for a follow-up survey to understand their changing views and behavior pattern. Three specific hospitals were identified for this purpose where wireless devices are used for data collection purposes. The hospitals were derived from government, private and regional sectors respectively.

While many techniques are available to capture perceptions and attitudes of usage of technology, this study employed an interview and a survey technique (Zikmund, 1994). This included open-ended responses to obtain factors that are not constrained by a pre-determined identification of constructs found in traditional surveys, as well as to determine the importance of the pre-determined factors. Given the exploratory nature of this study, these two techniques are considered important.

The instruments of this research constitute two broad categories of questions. The first categories of questions were related to the adoption and usage of wireless devices in hospitals for data collection purposes. 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 instrument. A two stage approach was used in administering the instrument, where the first stage gathered information about the key factors influencing nurses decision to use wireless applications and the second stage on the importance of those key factors. This approach was followed in this study in order to complement the open ended questions so as to determine the importance of the individual factors determining the adoption and usage of wireless devices and applications. This is not reported in this study, as the outcome has already been published.

For the purpose of this paper, the second stage data collected through the survey were analyzed through SPSS, by using the factor analysis technique to identify drivers and inhibitors for the adoption of wireless technology in healthcare environment. Finding pertaining to these is presented in this paper.

[2] The research design is adopted as a central theme in most of our other research work.

4. Qualitative

Data Collection and Data Analysis[3]

In this stage of the research a set of 30 interviews were undertaken. In order to ensure the interviews were conducted on time, the local health district was approached through one of the authors of this paper and suitable candidate groups were identified. After obtaining ethical clearance from both the principal university and the Health District, a research associate from the Health District was contracted to undertake the interviews. The interviews were conducted in such a fashion as to minimise any disruption to nurses' work schedule, ensure comfort of nurses in answering questions, minimise any travel time by interviewees, synchronise the 'interview' language with participants and to prompt nurses when unknown aspects were encountered by participants.

Prior to the interviews, the line managers were approached for permission to release staff for interviews. Initially a consent letter was distributed to obtain consent for interview and the list of people interviewed was provided to the Health District. The interview was recorded using a digital recorder and catalogued as per ethics requirement. These interviews were then transcribed for data analysis. Participants for the interview were selected from the nursing staff in Queensland Health. The participants were initially screened for suitability as only nurses working with technology were considered for this purpose. Any nursing staffs involved with administration only were eliminated from the interview to avoid any unforeseen bias. Nurses with a vast background were chosen (pharmacy, oncology and emergency departments). As the nurses belonged to the Health Department, no further screening was employed for sampling.

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The data was analysed using NVivo software application. Prior to the analysis of data, the interviews were transcribed using university services. The transcribed interviews ranged from 8 pages to 17 pages in length, covering a total of 260 pages of rtf format file. Two experienced transcribers were involved in the process of converting the interviews into a computer file. Once the files were transcribed, they were read while listening to the conversation in order to verify accuracy of transcription. Any bits that were missing during the transcription process were filled in as the researchers possessed sufficient knowledge of various technical terms used in this domain. The files were then printed and scanned for facilitators and inhibitors. These themes were identified on paper and then used as nodes in NVivo while examining the text files.

Once the themes were identified as free nodes using NVivo, the text snippets were examined again to aggregate the nodes into groups. Initially over 200 free nodes were realised and they were grouped into facilitators and inhibitors by examining the text passages again. They were grouped into the two major

[3] This part of the paper has been reproduces from the first stage publication in an international conference by both the author's of this paper.

categories as trees and a simple correlation analysis using the table facilities was also performed on the various nodes.

5. Results

The analysis using NVivo confirmed that the following facilitators and inhibitors can be extracted from the data collected from nursing participants. Our aim was in identifying the factors impacting wireless technology adoption. We did not attempt to classify them in an order of priority. However, we will be conducting more data analyses to classify them in proper groups and this exercise is beyond the scope of this project. The following tables list the facilitators and inhibitors of wireless technology adoption in nursing.

Table 1: Organized facilitators and inhibitors of the adoption of wireless hand held technology

Facilitators	Inhibitors
Volumes Of Information	User Friendly
User Friendly	User Friendliness
User Friendliness	Unreliable
Reduction Of Documentation	Testing
Quicker Response	Short Staff
More Timely Recording	Secure
Mental Health	Reliance
Medication Schedule	Problems
1medication Errors	Schedule
Managing Data	How Does It Work
Intensive Activities	Health Policy
Health Policy	Coverage
Handover Reports	Confidentiality
Fantastic Benefit	Awareness
Cut Down On The Paperwork	
Current Competence	
Benefits	
Avail Liability Of More Time	
Alert Clinicians	
Adverse Event	
Advantages	
Access Massive Amount Of Information	
Remote Monitoring	

7. Quantitative

Data Collection and Data Analysis

A survey instrument was developed from the findings of the stage one and 200 questionnaires were distributed among the healthcare professionals in the state of Queensland. Out of 200 questionnaires only 179 useable questionnaires were received. Responses from the survey were transcribed into a spreadsheet file and a visual basic interface was used to generate the numerical code to analyze the data by SPSS. Initially data was review for missing or incorrect values, descriptive analysis techniques were used to review the data from the SPSS as well. In-order to ensure the reliability of the instrument a reliability test was run on the complete instrument and the group of selected variables. The reliability test of Cronbach alpha was performed through the SPSS and value of 0.892 was received, which indicate high reliability.

Table 2: Reliability Statistics

Description	Cronbach's Alpha	No of Items
All the items in the survey questionnaire	.908	52
Items filtered through factor analysis	.904	43
Only survey questionnaire items selected in the first component (Factor 1 of factor analysis	.970	16
Only survey questionnaire items selected in the second component (Factor 2) of factor analysis	.836	12
Only survey questionnaire items selected in the third component (Factor 3) of factor analysis	.737	10
Only survey questionnaire items selected in the third component (Factor 4) of factor analysis	.884	7

Further, a data reduction technique, Factor Analysis, was used for the exploratory factor analysis. As can been seen from the table below a four factors, such as efficiency factors, organizational factors, communication factors, and reporting factors were identify for the adoption of wireless technology in the healthcare environment.

Table 3: Organized facilitators and inhibitors of the adoption of wireless hand held technology

Descriptions	Efficiency Factors	Organizational Factors	Communication Factors	Reporting Factors
Reduce-Workload	.785			
Improve-Public-Image	.655			
Improve-Clinical-Performance	.769			
Save-Time	.821			
Save-Effort	.820			
Reduce-Overall-Cost	.747			
Reduce-Medical-Errors	.837			
More-Contact-Time-With-Patients	.840			
Improve-Clinical-Workflow	.941			
Efficiency-In-Communication	.839			
Better-Quality-Of-Service	.882			
Improved-Delivery-Of-Information	.856			
Delivery-Of-High-Quality-Info	.896			
Reduce-Inaccuracies	.836			
Easy-Access-To-Data	.784			
Positive-Impact-On-Patient-Safety	.840			
Solutions Barrier		.671		
System Migration Barrier		.541		
Benefit Evaluation Barrier		.578		
Time For Training Barrier		.564		
Poor Technology Barrier		.644		

Incomplete Health Std Barrier		.777		
Lack Of Support Barrier		.638		
Legal Barriers		.704		
Security As Barrier		.637		
Device Usage Barrier		.606		
Device Comfort Barrier		.554		
Device Access Barrier		.530		
More-Training			-.780	
Tech-Support			-.716	
Electronic Medical Records			.613	
Obtain Lab Results			.641	
Administrative Purpose			.545	
Patient Education			.547	
Communication With Physicians			.633	
Communication With Colleagues			.660	
Communication With Patients			.524	
Electronic Prescribing				.826
Daily Scheduling Of Appointment				.532
Billing And Accounting				.804
Disease State Management				.749
Generating Exception List				.680
Note Taking				.544
Drug Administration				.563

A data reduction technique was used to group the related items together. Table 3 shows the factor analysis output of "rotated component matrix" with varimax methodology and factor loading set more than 0.5 to establish the natural grouping of the items in the instrument. This technique helped us to reduce the items into four factors groups. We name them as "Efficiency Factors" (EF), "Organizational Factors" (OF), "Communication Factors" (CF), and "Reporting Factors" (RF). Before conducting the second order regression analysis multicollinearity of the data was established with correlation analysis for the four factors. Correlation among the factors was less than 0.5, according to (Field, 2003) multicollinearity exist between the predictors if the correlations between the predictors is between 0.8 and 0.9. Therefore, multiple regression analysis was conducted to analyze the relationship between the improved clinical performance and the four factors identified through the factor analysis.

Table 4: Summary of regression analysis

Parameter	Value
R value	.75
R-squared	0.56
Level of Significance	0.000
F statistic	35.6
Regression Sum of Squares	67.6
Residual sum of squares	53.2

Constant (standard error)	.25 (0..423)
Coefficient for efficiency factors	.749 (0..000)
Coefficient organizational factors	.029 (0.650)
Coefficient communication factors	-.008 (0.907)
Coefficient reporting factors	-.074 (0.266)

Multiple correlation coefficient "R" for the four predictors "Efficiency Factors" (EF), "Organizational Factors" (OF), "Communication Factors" (CF), and "Reporting Factors" (RF), to determine the role of these factors for the "improve clinical performance" (ICP" for the wireless handheld devices in the Australian healthcare systems (R=.75). The adjusted value of the "correlation coefficient" for all the predictor clearly shows that 56% (R2 = .56) of the variation in the improve clinical performance is explained by the four predictors, EF, OF, CF, and RF. F-statistic, $F(4, 114) = 35.6$, $p < .05$ confirm the significant of the relationship of the four predictors to the dependent variable improvement in the clinical performance. The regression was highly significant ($p < .05$), and shows that healthcare professionals seems to believe that factors relating to efficiency, communication, reporting, and organization can have an influence on the improvement of the clinical performance and high quality of information.

8. Discussion

It can be seen from the above data analysis, Australian healthcare professional are quite concerned about change management and if the change management is not handled appropriately, it can have negative effect on the adoption of wireless technology in healthcare environment. Data analysis also highlighted, Australian healthcare professional are keen to adopt the wireless handheld technology with specific advantages or perceived usefulness indicating their awareness of reduction in error, quality of care, and clinical performances. Australian healthcare professional see the technology as with positive potential in the Australian environment toward clinical performance through the use of wireless handheld devices. Therefore it can be summarized; Australian healthcare professional seems recognize the value of using wireless handheld devices in an healthcare setting. These views and opinions mentioned in this study by the healthcare professional are either through their personal experiences or use of the handheld technology on a limited scale.

9. Concluding Remarks

This paper examined the potential uses wireless handheld device in healthcare setting and the identified the potential factors and their influences on the clinical performance for the adoption of wireless handheld technology in Australian healthcare setting. Respondent clearly mentioned there are certainly benefits in using the wireless handheld technology; whereas there are substantial, challenges needed to be addressed before the wider scale adoption in the Australian healthcare environment. While highlighting the challenges phased, this study conclude that Australian healthcare professional have positive image about the use of wireless handheld technology and can see through substantial benefits if implemented properly with appropriate support is provided. Future researches in this domain need to examine implications of wireless handheld technology at an organizational level in healthcare environment and their adoptability to unique healthcare setting.

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