

1-1-2011

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Recommended Citation

Hafeez-Baig, Abdul and Gururajan, Raj, "An exploratory Study to Investigate the Effectiveness of PDAs in Healthcare: A Case of Queensland Nurses" (2011). *ACIS 2011 Proceedings*. Paper 44.

<http://aisel.aisnet.org/acis2011/44>

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AN EXPLORATORY STUDY TO INVESTIGATE THE EFFECTIVENESS OF PDAS IN HEALTHCARE: A CASE OF QUEENSLAND NURSES

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Research in Progress

Abstract

This paper examines the role of wireless handheld devices such as PDAs and smartphones in the Australian healthcare system. The context of this paper is restricted to nursing staff in three regional hospitals. This study uses a mixed-mode methodology to understand the actual usage of PDAs by nursing staff in medical wards. The study identifies a list of issues and potential benefits associated with the actual use of PDAs for patient care in public hospitals. 30 nursing staff participated in this study and examined issues pertaining to the size, shape, weight, connectivity, and ease of use of the devices, as well as the perceived benefits, ICT infrastructure and the role wireless applications could play in nurses' intention to use the PDAs. This study also highlights that there is evidence suggesting that the use of the PDAs by nurses can improve the decision making process and the quality of decisions taken by nurses.

Keywords:

PDA, wireless handheld devices, healthcare, adoption, and actual use, decision making

INTRODUCTION

Over the last three decades, investment in information and communication technology (ICT) has had dynamic effects on various industries, including healthcare. This has resulted in increased productivity, higher quality of services and development of new processes. However, the healthcare industry has not enjoyed all these benefits as it has always operated with limited resources. Recently, the stakeholders of healthcare have become aware of the potential of information communication technology (ICT) and realised an opportunity to address some of the problems the healthcare sector is facing. It has been suggested that ICT has the potential to address issues such as reducing costs, errors and shortages of human resources; and improving funding, quality of care and satisfaction levels among customers and employees (Gururajan et al., 2008, Hafeez-Baig and Gururajan, 2010, Luanrattana et al., 2010, Wua et al., 2011).

Previous studies have clearly demonstrated that technological solutions alone will not solve the problems encountered in healthcare. For example, access to basic services is more critical than just reducing costs by automating or deploying some technology (Anogeianaki et al., 2004). Here, "access" can be defined as access to basic medical information at an affordable cost. Bensink, Armfield, Russel, Irving, and Wotton (2004) also concluded that deploying the latest technology alone will not solve the problems of the healthcare industry; it is also important to understand the adoption phenomena of a technology.

An example of ICT in healthcare would involve a hospital patient issued with electronically readable code, and hospital staff using wireless devices that can enter critical information directly into the hospital's data network. Through wireless devices, the patient's body could be connected to various hospital devices or equipment to record medical data such as blood pressure and heart function. These could be directly monitored, recorded and analysed by doctors located within the hospital or externally. Through wireless networks, doctors could order tests, prescribe medicines, and request other services generated directly from the bedside of the patient.

LITERATURE REVIEW

The healthcare industry has predicted that the development of ICT technologies, especially PDAs and smart phones, will have significant potential on its professionals to realise significant advantages. This is aptly reflected in the recent infrastructure investment and other technological developments in the healthcare environment (Hamalainen et al., 2007). The last three decades of investment in information and communication

technology have had dynamic effects on various industries including healthcare. Such an investment has resulted in increased productivity, high quality of services and development of new processes. However, the healthcare industry did not enjoy all these benefits as the industry has always been concerned with the risk associated with new technological developments. Recently, the stakeholders of healthcare have realised the potential of information communication technology (ICT) and have seen a window of opportunity to address certain issues the healthcare sector is currently facing. It is suggested that ICT, through PDAs, has the potential to address 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 (Hamalainen et al., 2007).

For example, a patient registering in a hospital may be issued with an electronically readable code and staff with wireless devices can enter critical information directly into the hospital network. Through wireless devices, a patient's body can be connected to various hospital devices or equipment to record medical data, such as blood pressure. Furthermore, other procedures such as the heart function can be directly monitored, recorded, and analysed by doctors internally and externally. Through wireless networks, healthcare professionals can order clinical tests, prescribe medicines, and request other services directly from the patient's bed (Gururajan, 2007, Kohn et al., 1999).

Among various other technologies, the use of wireless technologies is emerging rapidly in the Australian healthcare sector. Now the race is on to automate or redesign the clinical processes and increase the efficiency, productivity, quality of care, and to meet future challenges of the Australian healthcare sector. As it can be implemented quickly and relatively cheaply, wireless networking infrastructure can play an integral role within Australian healthcare. However, wireless technology in general can be used to automate processes, reduce paperwork, reduce duplicate processes, produce timely and up to date information, and standardise information. Wireless technology can also be used to support new and innovative processes and services in the primary, secondary, public, and private healthcare sector (Hu et al., 2002, Boric-Lubecke and Lubecke, 2010).

Cramp and Carson (2001) have suggested that in the future, healthcare delivery will clearly be predicated on two factors: the provision of an infrastructure based on ICT, and the availability of healthcare and other professionals who are able to utilise such infrastructure in order that healthcare be delivered in the best possible way.

Wisnicki (2002) discussed the implications of wireless technology to the healthcare industry and argued that it would improve patient care, make it more personalised, and provide analytical information to the medical practitioner that would allow for better decision making. Wireless healthcare systems could increase productivity and reduce costs, thus providing benefits for physicians, patients, healthcare professionals and insurance providers. Wisnicki also identified factors like learning processes, device acceptability, control and the changing roles of doctors as potential difficulties in the adoption of this technology.

Yampel and Esenazi (2001) studied the implications of the Graphical User Interface (GUI) technology on healthcare, with respect to wireless devices. The developments in GUI tools not only reduced timelines for the adoption of new applications, but also reduced overall costs and had positive implications for insurers and government agencies. These authors identified that resistance to the adoption of existing GUI and existing limitations of the wireless devices for healthcare applications were the main barriers to the adoption of wireless devices in the healthcare industry.

Turisco (2000) identified that features such as screen size, memory, slow data transfer rates, lack of single connectivity and storage capabilities can have a limiting effect on the use of wireless devices. His view was that the use of wireless devices would improve workflow and efficiency in professional healthcare settings. Alexander (2003) argued that current paper-based processes are costly and time consuming. He suggested that a transformation from paper-based systems to electronic systems would allow evidence-based healthcare data to be integrated with clinical and research data collected at the point of care.

This domain appears to be radically different to the 'wired' domain for the following reasons:

1. The data stream in the mobile device environment is based on small devices such as the PDAs that have limited processing capabilities;
2. The data are in small sets rather than huge databases;
3. The main purpose is to facilitate data access from anywhere and thus the concept of connectivity assumes utmost significance;
4. Users know how to access the data and hence training issues assume less significance in generic applications;
5. The access cost is affordable.

Although most of the literature advocates that healthcare organisations and professionals could benefit by the use of wireless technology, only limited studies are available which have actually tested these through use. The

basic objective of trialling the actual use of PDAs in the healthcare environment is to identify the views and opinions through use and to measure the effectiveness of PDA devices in the healthcare environment. This has prompted the following research question:

How effective are PDAs for nurses to perform their day-to-day activities in a healthcare environment?

RESEARCH METHODOLOGY

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.

In this study, a mixed-mode methodology was adopted to address the above research question. A qualitative approach was adopted to understand the rich, complex, and idiosyncratic nature of human phenomena (Cavana et al., 2001). This method of research can include interviews, focus groups, and observations (Cavana et al., 2001). This research adopted the interview approach to collect initial data about the use of PDAs by nurses. 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 was 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.

A quantitative approach can be used to measure the phenomena under investigation and the use of statistics to analyse the raw data to measure the effectiveness of PDAs in the healthcare environment (Cavana et al., 2001). This method of research uses questionnaires and laboratory experiments, and also statistical data gathered by organisations such as the ABS (Cavana et al., 2001). In this research study, a survey instrument was developed from the initial interview stage. The participants who participated in the trial were requested to fill in the survey instrument. The main reason for this approach was that previously tested instruments were found to be inadequate in the healthcare settings. 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 (containing a 5 point likert scale) was pilot tested to capture the information reflecting the perceptions and practice of those adopting the wireless technology in the 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 healthcare professionals from the three different locations of the trial of the healthcare facilities. 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.

DISCUSSIONS AND DATA ANALYSIS

In this research study, a mixed-mode research methodology was adopted due to the exploratory nature of the research and newness of the area of study. Both qualitative and quantitative techniques were used to collect views and opinions about the use of wireless handheld devices in an Australian healthcare setting, and both complimented each other and were triggers for the findings of this research study. In this research study we incorporated PDA's from more than one manufacturer, such as Nokia, HP, Samsung, Palm, i-mate, BlackBerry, HTC, and Motorola, to study the effects of physical characteristics of the PDA's in healthcare environment. Furthermore, all the hardware comes with different operating systems as well, such as Windows CE, Android, Palm OS, and Symbian. This strategy was adopted to find the suitability of various operating systems in the healthcare environment. Numbers of applications trial in this research were limited to few software applications to reduce the complexity as this was one of the finding from our earlier research. Researcher developed in-house specifically for this research projects a "Main Manu" application to facilitate the overall operation of the handheld devices in the healthcare environment. Other applications trial in this project includes local protocols, MIMS, medical calculator, medical dictionary, lab reference, and drug guide.

Qualitative data was collected through interview process during the trial period and revealed the following issues associated with the actual use of PDAs by nursing staff. 17 nurses and 2 Nursing Unit Managers (NUM) participated in the study. These 17 nurses used the PDAs continuously for a period of over 6 months. In addition to these, a post graduate student was also involved in the interviews. The trial involved a total of 60 nursing staff but many of them used the PDAs on a trial basis and staff that did not use the PDAs continuously were excluded from data collection. Small test sample tests were performed on quantitative data.

Table 1: Summary of logistic and technological issues identified by nurses

Logistic Issues	Technological issues
<ul style="list-style-type: none"> • There was a defined culture and it was not easy to break the culture to motivate older staff to use the PDAs 	<ul style="list-style-type: none"> • Due to the thick walls and layout of the wards the wireless connectivity was an issue at two locations
<ul style="list-style-type: none"> • Issues such as the physical location of the equipment's was a major concern at one of the locations 	<ul style="list-style-type: none"> • The actual size and weight of some of the PDAs did not suite nursing staff work routines and uniform
<ul style="list-style-type: none"> • The security and safety of the equipment was one of the concerns of the supervisor or the ward manager. 	<ul style="list-style-type: none"> • The unavailability of patent's information on the PDAs was associated with the actual use.
<ul style="list-style-type: none"> • There were occasions where the server was turned off due to unknown reasons. 	<ul style="list-style-type: none"> • The lack of a technology champion or easy technical help acted as barrier to the actual use of PDAs
<ul style="list-style-type: none"> • Health and safety procedure did not appreciate the ad hoc arrangements; at one location the location of the equipment had to be changed twice. 	<ul style="list-style-type: none"> • The screen size and process of inputting information seemed to be a major concern.
<ul style="list-style-type: none"> • Training seemed to be a minor issue, as younger or technology loving staff were happy to help others. 	<ul style="list-style-type: none"> • Battery life and charging time were raised quite often by staff as major issues.
<ul style="list-style-type: none"> • There was clear evidence and motivation among the nursing staff that PDAs could play a critical role in day to day activities of nursing staff. 	<ul style="list-style-type: none"> • The processing capacity of multimedia resources did not go well as it took a long time to run the application on the PDA remotely. • The scalability of the PDAs seemed to be major issues as users were not able to customise the device as they wished.

In spite of all these logistic and technology issues mentioned in Table 1, the overall feedback and the motivation of the nursing staff towards the use of PDAs in the wards was positive. For example, they were keen to have the trial extended, and at one location, the trial was extended twice. Nursing staff were very motivated and were keen to see that the use of PDA's become part of their everyday work. The advantages and potential offered by PDAs to nursing staff at the three locations is summarised in Table 2.

Table 2: PDAs for general healthcare and summary of benefits associated as perceived by nurses

No.	Benefits
1	There was clear evidence that a PDA could provide useful information on the move
2	The use of PDAs was able to assist with timely and better decision making
3	The trial provided clear evidence that use of PDAs can save, on average, 7% of the time for each shift, per nursing staff
4	Student nurses found the device very helpful for learning, and a source of reliable and accurate information

5	Patients were happy and had a positive attitude towards PDAs being used by nursing staff as they were able to answer their drug related enquiries
6	Nurses were able to spend more time on care
7	The mobility and use of PDA applications were perceived as improved security for the drug administrative-related issues.
8	Nurses perceived that PDAs as a technology had the potential for improved quality of care
9	Staff were confident that incorporating hospital data would ensure high usability of the PDAs
10	Nursing staff and the supervisor mentioned that PDAs could play an extensive role with intercommunication and the transfer of patients from one ward to another ward
11	Accesses to different healthcare procedures through PDAs were very beneficial, such as procedures to perform basic treatments or procedures to follow particular healthcare policies.
12	The availability of healthcare applications was another winner with the nurses; for example, nurses regarded the availability of MIMS on the PDAs highly
13	Nurses showed a great deal of interest for the potential uses of PDAs and the availability of various healthcare applications on the PDAs in the future
14	Training seemed to be not a big concern, rather the benefit offered by PDAs excited the nurses and they were happy to use PDAs without any formal training

The above table clearly indicates that PDAs in healthcare for nurses have great potential and provide benefit into their daily workflow and routine activities. Limited quantitative data was collected from the nurses who were involved in the trial of the PDAs.

Table 3: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.966	.962	41

The reliability of the instrument was measured through Cronbach's Alpha. As shown above, the Cronbach's alpha based on standardised items is .962. According to (Hair et al., 2006) this value corresponds to high reliability of the instrument (Paterson, 1994).

Once the reliability was ascertained, the survey items were further analysed to understand the usability and types of resources available on the PDAs that can be beneficial for the nurses. Data in Table 4 shows that decision making by nurses is a critical part of day to day activities and the availability of accurate and timely information can help to improve the decision making process. It appears that nurses rely on credible sources of information instead of relying on the experiences of colleagues for critical decision-making.

Table 4: Uses of PDAs for general healthcare and decision making by nurses

Descriptions	Agreed
Use Of PDAs For Decision Making	
It is essential for a nurse to have access to resources in order to make decisions for patients	88%

Would you agree that decision making for a patient can be time consuming if the resources are not available	94%
In your environment access to computer can be time consuming as others appear to be using it	88%
During working hours it is difficult to update knowledge about specific conditions	88.2%
In the majority of circumstances I rely on the experience of others for decision making	23.5%
Uses of PDAs for Procedures	
Policies and procedures on a PDA	94.1%
Patient Drug Alerts on a PDA	93.8%
Resuscitation procedures on a PDA	58.8%
A PDA for training purposes	93.8%
Primary Care manual on a PDA	76.5
Possible Uses of PDAs	
To have information on Cancer and treatment of pain on a PDA	94.1%
Drug calculation / composition for patients when you enter the basic data into a PDA	93.8%
Patient History and Known Allergies on a PDA	81.3
Potential PDA use	94.1%

The table above shows that nurses were able to see the benefits and potential uses of PDAs in healthcare facilities. For example, nurses were confident that PDAs could make a positive difference to the quality of care. Nurses were reluctant to use the PDAs for some specialised activities, as evidenced by the fact that only 58.8% agreed that PDAs could be useful for “Resuscitation Procedures”. Almost all the nurses agreed that PDAs could provide evidence that technology is mature enough to provide benefit to the healthcare industry.

Furthermore, correlation analysis was conducted among the PDAs’ ability to facilitate decision-making, the resources and applications available on the PDAs, and the training required to use the PDAs, to investigate whether there is any underlying relationship among these variables.

Table 5: Correlation analysis among decision-making, PDAs’ resources, training required, and PDAs’ application

Descriptions		Decision Making	PDA Resources	PDA Training	PDA HC Applications
Decision Making	Pearson Correlation	1	.715**	.244	.593*
	Sig. (2-tailed)		.001	.345	.012
PDA Resources	Pearson Correlation	.715**	1	.389	.800**
	Sig. (2-tailed)	.001		.123	.000
PDA Training	Pearson Correlation	.244	.389	1	.682**
	Sig. (2-tailed)	.345	.123		.003
PDA HC Applications	Pearson Correlation	.593*	.800**	.682**	1
	Sig. (2-tailed)	.012	.000	.003	

** . Correlation is significant at the 0.01 level (2-tailed).
* . Correlation is significant at the 0.05 level (2-tailed).

Correlation analysis between the variable Decision Making (DM) ability by nurses, PDA Resources (R), Training (T), and PDA Healthcare Applications (HA) shows there is a strong relationship between nurses' ability to make better decisions and the availability of healthcare applications through the PDAs. The correlation is statistically significant ($r = .8$, $p < .05$). The training seems not to be a big concern for the nurses in their ability to use PDAs for decision-making ($r = .24$, $p > .05$). Regression analysis also confirms this ($R^2 = .513$, $t = 2.15$, $p < .05$) (Stevens, 1986).

Further regression analysis was conducted to see if demographics characteristics of the participants have any effects on the prediction of uses of PDAs by nurses. The analysis shows that experience, gender, and age do not directly influence the decision to use the PDAs by nurses ($R^2 = .05$, $t < 1.95$, and $p > .05$) (Stevens, 1986, Tabachnick and Fidell, 1996).

The study indicates that nurse's feel that they are comfortable in using PDAs, and that PDAs will contribute to the quality of services offered by them to patients. However, this depends on the availability of PDAs and access to other infrastructure. In addition to this, the surveyed participants felt that relevant applications loaded onto the PDAs would help them to conduct their activities better in a ward.

During the qualitative stages, it was also learnt that nurses could save about 30 minutes of walking time per day by using PDAs in the ward. This saving is realised by referring to various reference manuals loaded onto the PDAs. Assuming that nurses walk about 5 miles per shift, this is a great saving. This saving can also be converted into other productive activities.

A main aspect that has been highlighted in this study through the data analysis was that data properly accessed by the nurses through the PDAs would help to offer better services and yet show productivity gains. Another aspect that was stated was the need to develop home-grown applications that are suitable for Australian healthcare. Nurses surveyed and interviewed believed that applications developed in foreign countries may not comply with the Australian regulations and hence may not be suitable for their work place. This is an important lesson because making investments in procuring applications that may not be suitable to nurses in their wards would prove to be a waste.

CONCLUSION

This study was a preliminary attempt to understand Australian healthcare professionals and their views about the use of wireless handheld devices in a healthcare environment. A mixed-mode methodology was adopted, and a qualitative study provided an insight into understanding the views and opinions of Queensland nurses. A quantitative study was developed from the findings of the qualitative study. In this research qualitative and quantitative techniques adopted to collect data complimented each other. This study clearly identifies the added value provided by wireless handheld technology for Queensland nurses, such as saving time, improved quality of care, help in decision making, and the availability of up to date information. Another finding of this study was

that healthcare professionals were concerned about the instigations of the existing infrastructure and the specific policies and procedures adopted by the Australian healthcare regulatory bodies and their implications.

FUTURE STUDY AND LIMITATIONS

It is understood that this is the first study of this kind, and that it was limited to a few hospitals with limited use of PDAs by nurses, but the study provides valuable information on the potential and actual uses of PDAs in the healthcare environment. The findings of this study cannot be generalised due to the limited scope of the study. Large-scale research study is required to generalise the findings of this research and to understand the adoption of wireless handheld technology in a healthcare environment, specifically in the context of the Australian healthcare setting.

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