

Adoption of Wireless Handheld Technology: A Case of Queensland Healthcare

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Abstract: Wireless technology is considered to a component of emerging technologies due to its relative newness in business. The mobility offered by this technology has influenced the introduction of this technology in healthcare, especially for nursing profession as nurses are always moving between patients and wards. The main advantage provided by this technology is collection of patient data at point of care, to manage patient schedules and to manage pharmaceutical information as these are the tasks performed by nurses in their workflow. Further, the technology offers flexibility and mobility to nursing staff to enable them to access data while they are moving between wards and patients. Despite many comments, it appears that user opinions on the adoption of technology specific to nursing are not prevalently available as current studies are focused on the technical aspects. This study, through a grant won from the Queensland Nursing Council in 2004, conducted a set of 30 interviews with nursing staffs to identify adoption factors. A qualitative technique, namely interviews, was used for data collection purposes and the adoption factors were identified using an NVivo analysis. The outcome of the interviews is reported in this paper.

Keywords: Mobile Commerce & Business, wireless technology, health care, IS

I. Introduction

Prior studies indicate that wireless applications using handheld devices can provide significant advantages by providing solutions to some of the existing problems that healthcare professionals face. These advantages include the reduction in transcription errors arising from paper based documents (Sausser, 2003), data collection at point-of-care (Simpson, 2003), considerable reduction in the amount of paper work required (Sparks et al., 2001), administering medications by having text based alerts using these handheld devices (Dyer, 2003), remote monitoring of patients and connecting to other systems such as patient care (Yacano, 2002).

While prior studies have highlighted the advantages of handheld applications, they have not yet ascertained factors that determine adoption of such a technology. This study is

designed to determine these factors. Once the factors of adoption are ascertained and appropriate solutions put in place, healthcare providers can enjoy the benefits of the application of this technology by providing solutions to staff associated with any crises encountered (Davis, 2002), managing the increasingly complex information challenges (Yacano, 2002), complying with the rigorous regulatory framework (Wisnicki, 2002), reducing the medication errors (Turisco, 2000), generating affordable applications that allow for greater mobility (Athey & Stern, 2002). In addition to these, wireless applications would also provide benefits to healthcare due to its flexibility and mobility in providing for better data management (Wisnicki, 2002), including complex patient data requirements (Davis, 2002), proper integration of data to existing systems (Craig & Julta, 2001), and improved access to data from anywhere at any time (Stuart & Bawany, 2001).

II. Literature Review

In healthcare literature, the concept of wireless technology is discussed by many studies (Wisnicki, 2002; Dyer, 2003; Simpson, 2003; Sausser, 2003; Hu et al., 2002). For example, Wisnicki (2002) 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 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 realised 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 those new IT technologies can help address some of the chronic problems encountered including saving nurses time, skilled nursing care and home health care. He also provides details on the expended time per every hour of nursing care and suggests that new technologies would provide solutions to some of the acute problems of nursing due to this time factor. 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 technologies in healthcare and potential benefits that can be achieved.

While many other studies reviewed in the healthcare literature echo similar sentiments, none of these studies have examined the potential problems in data collection methods using wireless devices. It appears that almost all studies have taken this crucial aspect for granted. While some studies have indicated existing problems in collecting patient data and provided some theoretical solutions, these studies have seldom analysed the changing nature of information systems using wireless devices.

To understand the issues associated with data collection using wireless devices, the Information Systems literature is also reviewed. Such a review indicated that this area is not fully researched. For example, Redman (2002) states that the wireless technology is in its infant stages and warns of the potential pitfalls when IT providers rush 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 relative high costs to initially set up these wireless networks is highlighted by Shroeder (1999); 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 to display 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), and Bevan (2001) discusses the potential problems of capturing data using wireless devices due to the 'hard-to-see display' nature of these devices. While the above mentioned studies warn that problems could be encountered while using wireless devices, they also tend to agree that the usage capabilities of these devices are growing and hence these hardware related problems will disappear in a few years time.

What can be realised from this review is that the majority of the studies have focused 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 can be grouped into the 'implementation' or 'management' of wireless technology in healthcare organisations as the cost appears to be a determining factor in such implementations. None of the studies reviewed appear to have examined the 'usage' aspects of wireless devices. While studies such as Davies et al. (1989) have examined the 'Technology Acceptance' in organisation and derived a model for such acceptance, the outcomes of such studies can't be generalised for wireless technology as the technology is radically different from the traditional desktop technology. With desktop technology, users source data by accessing them using wired and fixed devices. On the other hand, with wireless technology, the data comes to the users

via the hand held devices and this new paradigm gives users a lot of mobility and hence access to data.

While healthcare organisations are keen to save money, they are also keen to provide high quality services to their patients. Crucial to this high quality care is data collation and analysis for decision making. The raw data collected at point of care by nursing staff is converted into information by feeding the raw data into various organisational databases. Current literature highlights the importance of incorporating wireless devices in organisations without discussing how nurses are able to collect data effectively. Limited information is found on the factors of adoption and inhibitors associated with such devices. Therefore, this study conducted an investigation into the factors of adoption of wireless applications for data collection by nurses. The adoption consists of facilitators and barriers. The facilitators are the positive influence and the inhibitors are the negative influence. By doing so, this study will fill-in the gap in the literature and provide insights into those factors that need to be given priority while using wireless handheld devices for data collection purposes.

III. Research Plan

III.1 Research Problem

This research aimed to identify factors that determine the adoption of wireless handheld applications in hospitals for data management by nurses. This research examined potential challenges in adopting wireless handheld devices due to the rapidly changing nature of technology and associated legislative framework. Based on the initial literature reviewed, the following research questions were asked in this study:

1. What are the factors of adoption of wireless handheld devices in healthcare for nurses?
2. What are the emerging challenges in adopting wireless handheld devices in nursing?

III.2 Research Design

The focus of this research study was to investigate the factors of the adoption of wireless applications. Inference from the literature revealed that this was an under explored area which demanded investigation into the role of technology and that of human context in using the technology. Although prior studies in Information Systems and Health indicated that a quantitative approach would suffice, recent studies recommended that a combined approach (mixed methodology) of qualitative and quantitative methods would provide strength to the research outcome. Experienced researchers indicated that there was a need to include qualitative approach to study the human social and psychological factors (Remenyi et al., 1998).

The research study investigated human psychological factors such as training, ease of use, motivation, culture, causal ambiguity, absorptive capacity, and retention as factors influencing the adoption factors of new technology.

Factors identified for this research were limited and needed to be expanded further to accommodate other unknown factors that affect the adoption of wireless technology in a given setting. Hence this study included a qualitative approach with the use of interview methods to strengthen the research outcome.

This research was designed to capture a cross-sectional snapshot and a dynamic longitudinal picture of the acceptance of wireless handheld devices and their applications in hospitals. The data were collected using a qualitative technique, namely interviews. The data were collected from nursing staff involved in patient care and focused on their behavioural patterns of adoption and usage of current technologies and their opinion on the usage of wireless technologies. The interviews focused on understanding nurses' changing views and behavioural 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.

The qualitative method employed in this study included semi-structured in-depth interviews to gain a sufficient understanding on the topic from nurses using wireless technology in hospitals. These interviews helped to identify any unknown factors that affect the adoption of wireless technology.

III. 3 Data Collection

The data collection involved two specific stages. In the first stage we reviewed the existing literature in order to identify various issues impacting the healthcare domain where handheld devices can be used. This is called as the 'exploratory' stage. The main purpose of this stage was to identify factors in order to derive an interview instrument. The second stage involved actual data collection. These two stages are explained below.

Stage 1 – Literature Review (exploratory):

Extensive literature review was carried out at this stage to integrate the materials available into the interview questionnaire. The questionnaire consisted of over 20 themes and an information sheet was prepared after this comprehensive literature review. The specific purpose of this stage of the study was to ensure that nursing staff were comfortable in answering the technical aspects of wireless technology as appropriate to their working environment. This stage did not identify any mediating factors and only main factors influencing the adoption of technology were the focus of this stage.

Stage 2 – Interviews (evaluative):

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 nurses should be unbiased and should pertain only to technology and not the effects of technology on their current workflow. The samples for this project were drawn from the

Queensland health department and each of the samples is currently holding a practicing license. Further, the participants chosen are working in wards and people with administrative roles have been eliminated from the interview.

While Information Systems research identifies a range of sampling techniques such as random and clustering, the sampling technique used for this study is classified as 'purposive' sampling. As we need healthcare staff with special knowledge of technology, this approach was followed in this study. The samples were chosen through the local medical district on their advice as their opinions on wireless technology was extracted based on their knowledge. Therefore, the samples needed to exhibit certain attributes that are related to technology adoption. This approach has been followed in many health studies.

In the second 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.

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. 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 would gather information about the key

factors influencing users' 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.

III. 4 Data Analysis

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

III. 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 of the adoption of wireless hand held technology

Facilitators
1=Facilitators
2=volumes of information
3=user friendly
4=user friendliness
5=reduction of documentation
6=quicker response
7=more timely recording
8=mental health

9=medication schedule
10=medication errors
11=managing data
12=intensive activities
13=Health policy
14=handover reports
15=fantastic benefit
16=falls
17=cut down on the paperwork
18=current competence
19=benefits
20=avail lability of more time
21=alert clinicians
22=adverse event
23=advantages
24=access massive amount of information
25=remote monitoring

Table 2: Organized inhibitors of the adoption of wireless hand held technology

Inhibitors
1=Inhibitors
2=user friendly
3=user friendliness
4=unreliable
5=testing
6=short staff
7=secure
8=reliance
9=problems
10=schedule
11=How does it work
12=Health policy
13=coverage
14=confidentiality
15=awareness

III. 6 Specific comments on the factors

Facilitators – this factor indicates the positive influence of wireless technology on nursing. This factor also indicates that due to the positive mind frame, nurses will be keen to adopt the new technology in their setting.

Volumes of information – nurses indicated that wireless technology will help them manage the volumes of information. This can be realized due to the mobility and flexibility offered by the technology. This factor also correlates with data management, more timely recording and medication schedule.

User friendly – participants indicated that user friendliness of mobile applications will enable them to get their work done better. The distinction between user friendly and the next factor user friendliness was not clear. However, the term 'user friendly' was discussed while we were probing the technical aspects. Therefore, we believe that participants are referring to the applications used to conduct their daily work schedule and predominantly

indicate IT systems.

User friendliness – this factor was seen as a driver and was discussed while the management of technology was discussed. Therefore, we assume that the participants refer to the management of IT applications and the resources provided to them to conduct their jobs.

Reduction of documentation – this factor has been identified as a major driver by almost all interviewees. The nursing participants felt that wireless technology can provide the greatest advantage in this domain. This factor was linked to hand over reports.

Quicker response – this factor was mentioned in three specific contexts. The first one was accessing information in order to respond to various queries. The second aspect was in terms of various care management procedures. The third aspect was in terms of hand over reports and any query arising at this point of hand over. Participants believed that wireless technology in conjunction with better access would provide significant benefits in this domain.

More timely recording – participants felt that the mobility offered by the technology would enable them to record events in a more efficient manner than the paper based system. This factor was stated in conjunction with quick response and reduction of documentation.

Mental health – this factor was not recognized by all participants. We believe that this may be specific to a domain and highlighted in that context. Participants felt that wireless technology can help to track mental health issues such as monitoring patient movements using a handheld device. They expressed that wireless technology in conjunction with other technology such as Geographic Information System will accomplish tracking of patients specific to this domain.

Medication schedule – this is another area where participants felt that wireless technology can bring in significant benefits. Participants felt that handheld devices can help to track various details of medication schedules pertinent to patients. This factor was also linked with a reduction in paper work and timely recording.

Medication errors – this factor was almost agreed as a driver by all participants. The greatest benefit of wireless handheld technology appeared to be a reduction in medication errors. Participants commented that by introducing proper validation checks in the computer systems running on the wireless devices, instant validations can be facilitated leading to reduced medication errors.

Managing data – this factor emerged as a strong driver due to the mobility offered by wireless technology. Participants expressed their view that handheld devices will enable them to carry data as they move. This is also seen as a major paradigm shift in the way data is handled now. This factor is strongly correlated with a medication schedule and reduction in documentation factors.

Intensive activities – this factor was considered to be a less significant driver by the participants as they feel that the advantages provided by the wireless technology may be able to minimize the burden placed by their intensive schedule of

activities.

Health policy – this factor emerged as a driver despite the fact that certain participants questioned the current health policy. The consensus appears to be that if there is a proper health policy then the technology can deliver promises. Due to the positive perception exhibited by participants, we classified this factor as a driver, rather than an inhibitor.

Handover reports – participants expressed this as a major driver as almost everybody agreed that the wireless handheld devices can provide significant benefits in this domain.

Fantastic benefit – this aspect is categorized as a factor because the term ‘fantastic benefit’ emerged in many conversations. While participants were not able to clearly identify benefits, there is a positive feeling that the technology would be able to deliver benefits.

Falls – this factor was identified as a driver with a very specific cohort of participants coming from the aged care sector. We believe that these participants are already familiar with the handheld device to monitor aged care patients’ falls details.

Cut down on the paperwork – this factor emerged as a strong driver with links to reduced paper work and improved medication schedule. Participants agreed that handheld technology can definitely cut down paper work due to timely digital recording of data. Further, they also felt that this may reduce the errors such as transcription errors.

Current competence – this factor was discussed in a multitude of contexts. Some participants expressed that nurses are already handling a variety of technology and are therefore, competent enough to handle handheld technology. Others expressed that they are familiar with computing systems and hence possess necessary competence to manage handheld devices. This factor clearly indicates that nursing staff are not afraid of using new technology in their work.

Benefits – this factor was stated by a few participants while discussing the handheld technology. While this is a driver, the factor needs to be investigated further to identify what the actual and perceived benefits are.

Availability of more time – this factor emerged strongly with a number of people agreeing on this factor. The perception was that participants felt that they will be able to have more time to perform core functions because wireless handheld technology can assist them with data management.

Alert clinicians – participants felt that by using wireless technology, it may be possible to alert physicians in a more sophisticated way than the current ‘pager’ systems. They also felt that physicians can view various data associated with patients in a better way using the handheld technology.

Adverse event – this factor emerged as a driver because participants felt that wireless handheld technologies can provide more information in regard to adverse events because it is possible to store aspects of adverse events and retrieve them using this technology.

Advantages – this factor needs more investigation as participants stated there are advantages using wireless handheld technology. We were not able to glean more details from the interview schedule beyond this word.

Access massive amounts of information – this factor emerged as a major driver due to the perception that currently nursing professionals have to handle massive amounts of information which is carried in folders adding to the burden. Participants felt that the use of handheld technology may alleviate varying voluminous files and also provide access to data that is not available on hand while handling patients.

Remote monitoring – participants felt that wireless technology can facilitate remote monitoring using sophisticated methods. This emerged as a major driver because the majority of participants agreed that this be a driver. However, the concept of remote monitoring was expressed from monitoring a patient from their chairs to managing a patient in regional locations using this technology. This has a weak correlation with management's policy factor.

Inhibitors - this factor indicates the negative influence of wireless technology on nursing. This factor also indicates that due to the negative mind frame, nurses will NOT be keen to adopt the new technology in their setting.

User friendly – this factor indicates the technical component of wireless applications as applicable to nursing. Participants indicated that applications and computing systems should be user friendly in order to be adopted. It appears that current systems are not very user friendly and hence the negative bias in adopting new technology.

User friendliness – this factor was discussed by participants in terms of management support. Participants expected the supporting environment to be friendly in order for them to receive the necessary support.

Unreliable – this factor emerged as a major barrier because a number of participants discussed this under varying contexts from technology to management. The technical reliability of wireless coverage within health appears to be an issue. In addition, some participants also questioned the robustness of health policies in the wireless technology domain leading to major skepticism of the adoption of this technology.

Testing – this factor assumed minor importance as a barrier, as users insisted that wireless systems should be thoroughly tested prior to adoption. This factor was also correlated to education aspects.

Short staff – this factor emerged as a major barrier as many participants highlighted this issue. Participants highlighted the shortage of staff in health and its impact on technology adoption. One area that emerged here was the necessity for training and the impact it can have on staffing issues. This was weakly correlated to the policy framework.

Secure – this factor also emerged as a major factor as participants were concerned about this issue. The security factor was also discussed in terms of privacy and the impacts on their job. This factor had perhaps the most negative influence on the adoption of wireless handheld technology as it impacted performance.

Reliance – this factor was discussed by participants in terms of technology failure and their concern to resume

health activities without reliable technology. This factor was correlated with a number of facilitators such as access to information in a wireless environment.

Problems – this factor was categorized as a barrier because of the technical problems that can impact wireless handheld technology. This factor correlated with user friendliness in terms of support warranted when systems fail. Participants have again highlighted the need for robust policies in this domain and sufficient back up options.

Schedule – this factor was somewhat confusing as this was discussed under a variety of themes. The main negative feeling merged because of a proper schedule of wireless implementation in the participants' working environment. This has introduced a lack of direction as many participants encountered many different schedules for wireless implementation through varying policy statements.

How does it work – participants expressed this factor as a barrier due to the lack of training provided in the wireless technology domain. This factor was stated with the need for training.

Health policy – the lack of clarity in developing a rigorous policy framework has introduced a barrier to the adoption of wireless handheld technology according to the participants. They felt that a clear policy framework is essential as to the procurement of devices, usage framework, training, measurement etc.

Coverage – participants were uneasy as to the coverage aspects. This was discussed in technical terms and correlated with the policy framework.

Confidentiality – this factor emerged as a barrier when discussing access to information aspects. Participants highlighted that they were unclear as to the various confidentiality clauses and the impact on these clauses by using technology that is not well governed. This was considered to be a significant barrier by participants.

Awareness – this factor emerged as a result of the relative newness of the technology in the domain area. Participants expressed their concerns due to the newness of the technology in health and the need to raise the awareness as relevant to their profession. This also appears to be a major barrier in the adoption of wireless handheld technology.

IV. Discussion - Factors of Adoption & Emerging Challenges

Once these facilitators were identified from the interview notes, an effort was made to group them based on some arbitrary common themes among factors. While the interview data was analysed based on context, it was possible to extract four broad themes namely: ocumentation, information management, advantages and benefits. The documentation theme refers to any incentives to reduce paper work encountered by nursing staff. Information management refers to access to information and associated aspects. Advantages refer to positive and direct influences encountered in their daily operations. Benefits refer to

influences at organisational level as viewed by nurses. Themes that fitted these groups were identified and clustered under these four factors and a model was derived using NVivo.

Previous studies have already indicated that information management (Sparks et al., 2001) is a significant advantage using wireless technology. This was discussed by previous studies in terms of time management due to reduced information load (Sparks et al., 2001), reduction in medication errors (Sausser, 2003), and reduced documentation (Yacano, 2002). This study agrees with the previous notion that information management can be made easy by using wireless technology adoption. The new factors such as user friendliness, quicker responses, timelier recording and availability of more time for routine work appear to be the facilitators of the adoption of technology for healthcare professionals. Other comments indicate that healthcare professionals believe that the reduction in documentation and the quicker responses associated with the technology would be significant drivers of adoption. If adoption is slow, it may be more an indication of implementation problems rather than the perceptions of the relative advantage of the technology.

The inhibitors reveal details that are not found in the literature yet. For instance respondents considered the surrounding infrastructure to be a barrier to enable the technology. This is reflected in their statements to the effect that short staff, policy and work schedules are all considered inhibitors in adopting the wireless technology. This needs further investigation. The lesson from this exclusive exercise is that the factors of data management will drive the adoption of wireless technology in healthcare as this is where significant advantages can be gained. While some factors reported in this study are already highlighted by previous studies, this is perhaps the first attempt to extract views from users in a systematic manner. In addition to wireless technology, work settings appear to be impeding the adoption of technology. The implication of this aspect is that, in addition to the introduction of wireless technology, healthcare managers should consider the working conditions of their staff as these conditions enable the use of technology. In terms of theories used in the Information Systems Domain, there are five dominating aspects to technology adoption in any given setting. They are (i) relative advantage, (ii) compatibility, (iii) complexity, (iv) trialability and (v) observability. These five themes are well justified in this study. For instance, the theme 'Relative Advantage' is justified by the information management concept as expressed by the healthcare people in this study. 'Compatibility' is established through various discussions on access to resources including technology and devices. 'Complexity' is discussed by the participants by the information overload and the benefits that technology can bring in terms of time savings. 'Trialability' is highlighted by the fact that 'the technology is here to stay' and their implied willingness to trial new systems. Finally, the 'Observability' is mentioned in terms of various benefits that

can be provided by the technology.

In essence, while some factors correspond to the literature, emerging new factors indicate the benefits that this technology can bring to healthcare and associated facilitators of adoption. The next level of this research will look at the factors outlined by Rogers using an in depth analysis of the interviews and relate them to the factors identified by the nurses during their interviews.

V. Significance to Nursing

The study is significant to nursing for many reasons including the mobile nature of nurses, heavy data access when on the move, hand over reports, etc. Literature indicates that handheld devices can provide significant advantages to nursing by providing solutions to some of the existing problems such as the reduction in transcription errors arising from paper based documents (Sausser, 2003), data collection at point-of-care (Simpson, 2003), reduction in considerable amount of paper work (Sparks et al., 2001), administering medications by having textbased alerts using these handheld devices (Dyer, 2003), remote monitoring of patients and connecting to other systems such as patient care (Yacano, 2002). While prior studies have highlighted the advantages of handheld applications, they have not yet ascertained factors that determine adoption of such a technology. This study is perhaps the first attempt in Australia to identify these advantages by talking to nurses using an interview instrument.

VI. Conclusions

We found out that the adoption of wireless hand held technology by nursing staff received mixed feedback. While the facilitators are more than the inhibitors, issues such as security and awareness indicate the concerns to adopt new technology.

The driving force behind the adoption of wireless technology in a nursing domain appears to be the access to information and the management of volumes of information. While these two factors emerged strongly as facilitators, participants also felt that these two factors can reduce errors and paper work. We recommend that further research is now conducted on the issue of access to information, inclusive of an impact analysis.

In terms of inhibitors security, confidentiality and policy framework appear to be inhibiting the adoption. It can be noted that these factors are directly related to the management of technology rather than functional aspects of technology. These factors when combined with awareness and education issues indicate the reluctance of nursing staff to use the technology as the direction is not clear to them. If security, confidentiality and policy framework have effective corporate governance in raising staff awareness, this should overcome the barrier.

In essence, the data indicates that the facilitators are facilitated by the potential this technology can offer and the

inhibitors are the lack of management direction provided by the department or by the operating environment. In our opinion, while there is considerable enthusiasm to adopt new technology such as this, the participants are reluctant because they were not provided with comprehensive information as to how this technology can benefit them. This can be highlighted as an awareness issue, which is easy to rectify.

We believe that the effect of inhibitors can easily be minimised by adopting a training and education framework. This training framework will inform the nursing staff of the benefits, the policy framework and regulatory framework in their working environment. Once this is covered, a simple trial pushed from the top will enable staff to actually experience the benefits. This coupled with better technical support will influence users' decision to adopt wireless technology in their working environment.

We recommend that when considering the implementation of wireless technologies into the nursing profession that the adoption factors outlined in this report are taken into consideration.

In summary we believe that we have generated through this research an effective implementation model that will assist nurses considering the acquisition of such technology.

References

- [1] Athey, S., & Stern, S. (2002). The impact of information technology on emergency health care outcomes. *RAND Journal of Economics*, 33(3), 399 - 388.
- [2] Atwal, R. (2001). The wireless office: Evolution, Revolution or Bust (No. PCIS-EU-DP-0101): Gartner Research.
- [3] Bevan, N. (2001). International standards for HCI and usability. *International Journal of Human-Computer Studies*, 55, 533-552.
- [4] Craig, J., & Julta, D. (2001). *e-Business Readiness: A Customer Focused Framework*. Boston: Addison Wesley.
- [5] Davies, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Communications of the ACM*, 35(8), 982-1003.
- [6] Davis, R. (2002). Pursue front end solutions to revenue problems. *Healthcare Financial Management*, 56(8), 30 - 36.
- [7] Dyer, O. (2003). Patients will be reminded of appointments by text messages. *British Medical Journal*, 326(402), 281.
- [8] Hu, P. J., Chau, P. Y. K., & Liu Sheng, O. R. (2002). Adoption of telemedicine technology by health care organizations: An exploratory study. *Journal of organizational computing and electronic commerce*, 12(3), 197-222.
- [9] Redman, P. (2002). Wait to Invest in Next-Generation Wireless Services (Research Note No. T-15-2354): Gartner Research.
- [10] Remenyi, D., Williams, B., Money, A., & Swartz, E. (1998). *Doing Research in Business and Management*. London: SAGE Publications Ltd.
- [11] Sausser, G. D. (2003). Thin is in: web-based systems enhance security, clinical quality. *Healthcare Financial Management*, 57(7), 86-88.
- [12] Shah, M. (2001). Grassroots Computing: Palmtops in health care. *The Journal of American Medical Association*, 285(13), 1768 - 1769.
- [13] Shroeder, S. (1999). Wired for business. *Risk Management*(March), 12-22.
- [14] Simpson, R. L. (2003). The patient's point of view -- IT matters. *Nursing Administration Quarterly*, 27(3), 254-256.
- [15] Sparks, K., Faragher, B., & Cooper, C. L. (2001). Well-Being and Occupational Health in the 21st Century Workplace. *Journal of Occupational and Organizational Psychology*, 74(4), 481-510.
- [16] Stevenson, S. (2001). Mobile computing places data in the palm of the hand: Devices deliver real-time access to information. *Ophthalmology Times*, 26(4), 15 - 18.
- [17] Stuart, D., & Bawany, K. (2001). *Wireless Services: United Kingdom (Operational Management Report No. DPRO-90741)*: Gartner.
- [18] Toms, G. E. (2000). Understanding and facilitating the browsing of electronic text. *International Journal of Human-Computer Studies*, 52, 423-452.
- [19] Turisco, F. (2000). Mobile computing is next technology frontier for health providers. *Healthcare Financial Management*, 54(11), 78 - 82.
- [20] Wisnicki, H. J. (2002). Wireless networking transforms healthcare: physician's practices better able to handle workflow, increase productivity (The human connection). *Ophthalmology Times*, 27(21), 38 - 41.
- [21] Yacano, F. (2002). Monitoring air quality: handhelds and wireless tools from efficient links. *R & D*, 44(5), 42 - 46.
- [22] Zikmund, W. (1994). *Business research methods (International Ed. ed.)*. Orlando, FL: The Dryden Press.