December 2006

Personal Digital Assistants Adoption in Healthcare:a Nurses' Case Study

Elisa Morán
CICESE- Mexico

Ana Martínez
CICESE- Mexico

Victor González
University of Manchester

Jesus Favela
CICESE- Mexico

Julia Mora
IMSS- Mexico

Personal Digital Assistants Adoption in Healthcare: a Nurses' Case Study

Elisa B. Morán-Solares
CICESE, Mexico
elmoran@cicese.mx

Ana I. Martínez-García
CICESE, Mexico
martinea@cicese.mx

Víctor M. González
University of Manchester, UK
vmgonz@manchester.ac.uk

Jesús Favela
CICESE, Mexico
favela@cicese.mx

Julia Mora-Altamirano
IMSS, Mexico
julia.mora@imss.gob.mx

ABSTRACT

Recent reports show that Personal Digital Assistants (PDAs) are being widely used in healthcare and their level of use is expected to rise rapidly. However, it seems that PDAs adoption is not experienced in the same way by all types of medical workers, in particular nurses. Even tough there is some evidence pointing to some barriers for PDAs adoption by nurses, there exists little empirical investigation that explains how the adoption occurs within the context of daily nurse practices and with a longitudinal perspective. This work presents the results of a technology adoption case study, carried out with a group of nurses of a public hospital. We identify PDAs critical adoption factors such as training, previous use of technology, language, fears, as they are experienced by our informants. In contrast with previous studies, our results highlight the importance of studying adoption as a multi-stage phenomenon as critical factors become more or less relevant at different stages. We discuss the implications of our findings for the successful introduction of PDAs in nursing practices.

Keywords

Adoption, handheld, critical factors, PDAs

INTRODUCTION

Recent studies indicate that PDAs are becoming important tools in healthcare (Carroll and Christakis, 2004; Criswell and Parchman, 2002). Particular characteristics of these devices that call physicians' attention are: the size, PDAs are small and lightweight, facilitating to take them everywhere; the input mechanisms in form of a pen, which seem natural to the current health care practices; also they provide connectivity with other devices through infrared transmission or other means. Some studies indicate that healthcare professionals use PDAs to assist them in both, medical practices and administrative duties. They can access medical literature, prescribe to patients, check medical records and order laboratory tests. Furthermore, it has been reported that medical workers use PDAs to coordinate schedules, manage facilities and communicate with colleagues (Fischer et al. 2003). In spite the clear benefits of PDAs that some studies have identified, other research points to diverse challenges for their adoption in nursing practice. (Hunter, 2003) stated that nurses have trouble adopting Information Technology (IT) because they are an aging population with little or not IT training, nursing schools do not have enough IT training, and nurses feel that IT is dehumanizing. In another study (Abraham, 2004) argues that some other reasons behind the low adoption of PDAs are: the lack of technical support during the use of the devices, as well as the little understanding of this kind of medical work involving mobility, intense handling of information in the point of care, task dependency of time and location. In the last years, diverse investigations have been focused on identifying factors that facilitate and prevent the adoption of PDAs in different working contexts (Kleijnen et al. 2003; Sarker and Wells, 2003), but little empirical investigation exists that identifies how adoption occurs within the medical context, particularly in nursing daily practices. To address these aspects we conducted a study where we analyzed how PDAs were adopted by nurses working in a hospital. This study enabled us to identify the critical factors for the adoption of the technology, from the basis of an analysis of a

practical process of adoption. The integration process, on which this study is based, was carried out in a hospital of the locality, having as participants a group of eight nurses of the internal medicine area.

RELATED WORK

The literature offers results of studies indicating the benefits of mobile computing for medical workers (Dee et al., 2005; Fischer et al. 2003; Grasso and Genest 2001). In most cases these studies are centered in particular roles, such as physicians. However, to be able to exploit the full potential that the technology offers in health care, it is important that not just physicians but other roles are able to adopt the same technologies. A role that reports problems associated with the adoption of PDAs are nurses (Courtney et al. 2005).

Previous studies, focusing in the adoption of IT in general can provide some initial insights to explain why this adoption is problematic. (Thong, 1999) proposes that the adoption of technological innovation may be depicted as a three stage sequence: *initiation*, the stage concerned with gathering and evaluating information about the technological innovation; *adoption*, in which a decision is made about adopting the technological innovation and *implementation*, which involves implementing the technological innovation in the business. Based on this model and distinctive characteristics of mobile technologies and the organization, (Li et al. 2005) developed a framework which consists of three dimensions, including environmental, organizational and technological factors. Li used this framework in a study conducted to examine the critical factors that may affect the adoption of mobile nursing technologies. Based on a survey with 193 nurses and administrators of 31 medical centers and regional hospitals of Taiwan, Li found that the mobile nursing technology adoption was significantly associated with business competition, the capability of external supplier, and internal needs. In spite the value of this work, one of its limitations is that the researchers put the emphasis on the dynamics of supplying and administering IT, rather that on the realities of nursing work and how mobile technology affects it.

In other study, (McAlearney et al. 2004) performed an investigation of the use of PDAs by physicians in a clinical setting. The results showed that the main factors that influenced PDA adoption were: the device itself, personal and perceptual constraints. The perceptual factors were comfort with technology, preference for paper, and the impression that the devices are not easy to use. In addition, they suggested that organizations can help promote PDAs adoption by providing advice on purchase, usage, training, and user support. In an investigation performed by (Lu et al. 2005) he found similar findings, but also suggested other aspects to take into consideration, among them the impact of the applications to the medical workers workflow, usability barriers, maintenance and security concerns, technical problems and negative patient perception.

Another effort to understand adoption of technology by nurses was made by (Ammenwerth et al. 2006), who found that the existing frameworks such as the technology acceptance model (TAM) and task technology fit (TTF), are failing to include one important aspect for the adoption: the interaction between user and task. Therefore, they propose a framework called Fit between Individuals, Task and Technology (FITT), which is based on the idea that IT adoption in a clinical environment depends on the fit between individual's attributes (motivation, stress, etc.), technology's attributes (usability, performance, functionality, etc.) and the attributes of clinical tasks (task complexity, organization, interdependence between them, etc.). This framework was used in a study to analyze in retrospective the adoption of a nursing documentation system in various departments of a German University Hospital. They found that the factors affecting the adoption of the system were: attributes of individuals - preference to written nursing documentation, computer skills, professional experience, support and trust within the nursing team, etc.; attributes of technology- software functionality, usability and easy to use of software, stability and flexibility, etc.; attributes of task- amount and level of detail of documentation, long times with patients, etc.

In spite of the diverse efforts made to establish the factors that facilitate and prevent the adoption of PDAs, there is not a consolidated model describing the dynamics of the key elements that facilitate the technology integration and adoption. We still need to know how PDAs are adopted in healthcare environments, from the base of an evaluation of the practical process of adoption as nurses go with their daily work. In the next section, we describe a PDAs integration process that we studied with the purpose of understanding how nurses adopt the technology, and detecting the critical factors that emerge throughout this process.

PDAS INTEGRATION PROCESS AT THE HOSPITAL

In this section we describe the integration process of PDAs followed at the Hospital. The results of this process were analyzed to determine the possible factors that can influence the adoption of these devices by nurses. This process was conducted in a hospital in the city of Ensenada, Mexico; this is a public institution providing health services to about 82% of the city's population. In the last years, the hospital has been integrating new technologies such as electronic medical records; and analyzing the integration of PDAs, public displays, etc., to improve the quality of care. The hospital did a pilot project to

integrate PDAs in the internal medicine area, and we were allowed to follow and analyze this integration process, which consisted of the following phases:

1) Initial phase: During this phase, it was determined that the PDAs integration process would be carried out in the internal medicine area, where the work activities are intense, there are many interactions, and hospital staff experiment high mobility. An important task of this phase was to give some talks to staff of the area; this was done to introduce them to the project and to provide information on the possible benefits that the use of PDAs can bring in supporting their activities. At the end of this phase, we identified eight nurses that accepted to participate in our study.

2) Training phase: Here, the integration process started in the internal medicine unit. The PDAs and their manuals were distributed to each nurse. Two training courses were provided; the first of them was a basic course, where nurses learnt PDAs fundamentals and how to use basic tools, such as: calendar, alarms, notes, contacts, etc.; then they continued with an advanced course, where they learnt how to use programs such as a word processor, spreadsheet processor and e-mail messaging. During this phase some personal computers, PDAs cradles and a local network were installed in the area.

3) Use phase: During this phase two types of PDAs applications were introduced. Firstly, we introduced a set of *basic tools,* which included a dictionary (translator language, synonymous and antonyms and medical terms), and a personal calendar system. Secondly, we introduced a set of *support tools* which included calculators (body mass, blood pressure, etc.) and two nursing specific applications: the CBMed and Nurses' Protocols. The CBMed application is a digital pharmacopoeia that stores information about medication used in the hospital. The nurses' Protocols application is a digital nurse guide to provide patient care.

The PDA integration process took approximately one year; during this time we followed all events and actions presented while nurses adopted the PDAs. In the next section, we describe the methodology followed in the study of the adoption process.

METHODOLOGY

The methodology followed is composed of the next five components: 1) review of adoption models and techniques, 2) understanding nursing practices and medical professional work, 3) data collection: observation during an integration process and interviews, and 4) qualitative analysis of data collected.

Component 1: Review of adoption models and techniques

During this we reviewed some of the models and techniques that have been used in previous technology adoption studies performed inside and outside of hospital environments. The objective was to determine if some of these tools could be applied in our study.

Component 2: Understanding nursing practices and medical work

This study started with an observational activity conducted for five weeks, where nurses and medical workers were closely observed and interviewed by a couple of researchers. Each subject was shadowed for two complete working shifts to know in detail the activities and behaviors performed by hospital staff, such as: use of information and resources, tasks performed, interactions, mobility experimented during a work shift, etc. Thus, all activities were recorded as they occurred, with as much precision as it was possible.

Once the observation was concluded, we validated and complemented the information gathered during the shadowing by conducting a couple of interviews to the subjects.

Component 3: Data collection

Interviews

One of the techniques used for gathering the information was formal interviews with the eight nurses participating in our study. Each interview took about 60 to 90 minutes and all were audio recorded. Topics covered during these interviews included general use of PDAs, expectations, observed barriers, challenges, organizational support, perceived benefits of using PDAs, etc.

Observation during the PDA integration process

For understanding the integration process from the basis of the practical processes of adoption, we also participated as observers, getting involved with the group of nurses that participated in the study. The data collected during this phase were

very rich, as we directly observed the way that nurses made decisions, the development of their activities and the use of technology.

Component 4: Qualitative analysis of data collected of the PDA integration process

All the interviews were transcribed, and then we began the analysis of our data using grounded theory techniques, such as *open* and *axial coding* (Strauss and Corbin, 1998). In the next section, we describe the steps followed during these techniques.

Open coding

It is the analytic process through which concepts are identified, followed by the delimitation of their properties (characteristics that delimited and give a meaning to dimensions) and dimensions (Strauss and Corbin, 1998). The process followed is described next: 1) we examined the transcripts, paragraph by paragraph, searching concepts that could describe the phenomenon studied; 2) these concepts were added to a list; 3) once we finished examining all the interviews, the "concept list" was refined, keeping the concepts that have a strong relationship with the phenomenon; 4) later, we grouped these concepts based in similar characteristics, types of actions, behavior, etc.; and 5) finally, we obtained a set of categories that aim to describe the adoption phenomenon.

The final version of our categorization scheme was the result of repeating several times the process described above. During this iterative process, new ideas and concepts emerged. By the end of the last iteration no new major concepts emerged.. Once we had the final version of the scheme, we identified the associations that existed between the categories with the axial coding technique, which is defined in the next paragraph.

Axial coding

It is the process of relating categories to their subcategories, termed "axial" because coding occurs around the axis of a category, linking categories at the level of properties and dimensions. This process enables us to establish if there is an influence among the factors, and whether it has a negative o positive impact.

FINDINGS OF THE STUDY

The critical factors that influence the PDAs adoption were composed by the following main categories: *personal, technological, informational, environmental, organizational;* established during the four phases of the adoption process. As it can be observed in the final version of the categories (Table 1), category properties changed depending on the adoption implementation process phase in which nurses were.

Critical adoption factors in the initial phase (previous to the training sessions)

The results of the qualitative analysis show that the factors that impacted the PDAs adoption during the initial phase are: personal, environmental and the nurse pre-conception of the use of PDAs.

Analyzing the personal factors, we identified a property of *skills and knowledge* which has the following dimensions*: previous experience with similar technology* and the *technology knowledge (background)* that nurses have concerning to the technology implemented. For example, the nurses that have experience with personal computers mentioned that it was less difficult to learn how to handle the PDA. Also, they expressed that the perception of the PDA being difficult to use, decreased because they had some idea of what the PDA is, what they can do with it, etc. As a result, the resistance also diminished. Hence, we concluded that these two dimensions contributed positively to PDA adoption. Also, we found with positive influence the *motivation* classified inside the *psycho-social* property. In favor of this, nurses mentioned that they felt good when they knew that they were selected to participate in this process, because that would give them the opportunity of taking part of the modernization process, not only be spectators as usual. As a result, their desires to participate increased, accepting the challenge of integrating PDAs in their work practices.

We identified a property of *characteristics of nursing practice, i*n the environmental factors, which has two dimensions: *mobility* and *priority to provide direct patient care.* Respect to mobility, during the shadowing we observed that, nurses need to displace and move constantly around the bed wards, nurse pavilion, and other places, to conduct their work. Nurses expressed that due to this, PDAs were perceived as a possible candidate technology to fulfill some of the needs demanded by their mobility. The nurses perceived that the main benefit that PDAs could offer would be to provide a way to capture and access to clinical information where and when the information is needed. As a result, they could reduce some information management problems, such as: double capture of information, avoid moving from one place to another looking for

information, etc. The time they invested in these tasks could be used instead in direct patient care activities or in other activities indirectly linking to the patient care. As we can know intuitively, we found that nurses feel a strong commitment of providing an excellent care to patients, thus, they expressed that direct patient care has the priority over other activities. It is important that nurses can see that the benefits offered by the PDAs can help them to provide a better patient care.

Initial phase		
Category	**Properties**	**Dimensions**
Personal	Skills and knowledge	Technology knowledge
		Previous experience with similar technology
	Psycho–social	Motivation
Environmental	Characteristics of nursing practice	Priority to provide direct patient care
		Mobility
General conception of PDAs and their use	Usefulness perceived	Information access and storage
Training phase		
Personal	Skills and knowledge	Language
	Psycho-social	Stress
		Motivation
Technological	Infrastructure	Physical characteristics of the device
Organizational	Administration commitment	Training program
Use phase		
Organizational	Administration commitment	Reach and permanent technical support
Environmental	Characteristics of nursing practice	Free time available
Technological	Type of applications	Basic tools
		Support tools (CBMed application, Nurses' protocols)
Future use		
Informational	Information management	Legibility and information transfer
Technological	Information protection	Security and privacy mechanisms

Table 1. Critical adoption factors for PDA adoption presented during integration process

Finally, we found that another aspect that influenced PDAs adoption was concerning to the *general conception of PDAs and their use*, which has a property of *perceived usefulness;* This has a dimension of *information access and storage;* nurses expressed that they perceived would be very useful to capture and access clinical information where and when the information is needed.

Critical adoption factors in the training phase

The results of the analysis showed that factors that impacted in this phase are: personal, technological and organizational.

We found that the *language* dimension of the *skills and knowledge* property concerning to the personal factor, had a negative impact for the adoption of the PDAs. The problem here was that almost all nurses do not know the English language, therefore the fact that the PDAs' operative system was in English, made difficult to handle the device; they did not understand the instructions or did not remember options' names. In consequence, the PDA use was limited. Also, other factor that had a negative influence was the *stress* experimented by the nurses during this phase, this is a *psycho-social* property. We identified that this negative sensation was caused for several reasons such as: the little progress obtained during the training sessions, caused by the little experience that some nurses had at the beginning of this phase; they did not get completely concentrated during training sessions, for interruptions or listening that someone was looking for them, etc. In addition, the reasons mentioned before took us to discover another category that we named organizational which has a

training program factor belonging to the *administration commitment* property. Concerning this, nurses expressed that they considered that it would have been better if the training sessions were carried out in a classroom, away from the bed wards and with an established schedule, avoiding with this some of the stress mentioned before. They also suggested the design of different training programs ad hoc to different nurses' computing experience. However, during the analysis we found that this also had a positive influence for the PDA adoption. Nurses mentioned that if it was not considered giving *a training program*, it is almost sure that their PDAs would remain stored in their packages.

Finally, another category that we identified was the technological factor, which has the dimension of *physical characteristics of the device (fragility)* belonging to the *infrastructure* property. Nurses mentioned that they considered that the PDAs are fragile, thus, they need to be careful where they put them, avoid breaking them or losing them. Thus, this looks like something unfavorable; nurses expressed that they need a stronger device to fulfill they work support technology needs.

Critical adoption factors in the use phase

The factors that impacted in this phase are: organizational, environmental and technological.

Analyzing the organizational factors we found that the a*dministration commitment* property also impacted in this phase, as well as aspects related to *reach and permanent technical support*. Nurses mentioned that having near the technical support team enabled them to clarify doubts quickly, solve problems, etc. Thus, to locate the technical support team in a strategic place near by was a factor that impacted positively in the PDAs adoption.

Concerning the technological factors, we found that depending of the value that the *type of application* property has, the impact would be positive or negative this is because it is linked with the usefulness of the application. For example, the CBMed application of the s*upport tools* dimension had wide adoption. Nurses commented that this application was very useful because it enabled them to search quickly specific medication information, such as doses, etc. As a result, they save the time used before to look for a colleague or call to pharmacy to ask for this information; thus they can use this time in another activities. On the other hand, a Nurses' Protocols application of *support tools* did not have the high expected adoption. The reason for the low use of this application was that they already had the knowledge and experience of most of the diagnoses contained in the application, and therefore it was rare consulting it.

Finally, we found that another factor that impacted the adoption was *environmental*. Concerning this, we identified a property of *characteristics of nursing practice*, where we found that the dimension of *free time available* to practice or use the PDA was influencing the adoption. Nurses commented that, although they had interest in practicing with the PDA or using it, they did not have much time to do it for the workload due to the number of patients; critical condition of the patients assigned to their care or other priorities work activities.

Critical adoption factors in a future use

One of the objectives considered in the PDAs integration process was to implement a nursing chart application, but for different reasons this task could not be carried out. In spite of this, we consider important to have the perceptions of the nurses concerning having the patient's nursing chart application in the PDAs. We found that the factors that would impact PDAs adoption in a future are: informational and technological.

Analyzing the technological factors, we found that there exists an *information protection* factor which has a *security and privacy mechanism* dimension that would have an influence in the PDA adoption. Concerning this, nurses expressed the importance of the security and privacy issues in the development of future applications; especially applications such as the patient's nursing chart that has critical patient information. Thus, any alteration would cause a legal problem or a negative consequence in patient health.

Concerning the informational factors, we found that the *information management* property could have an impact in the PDA adoption. When we explored the data, we found that this property has a dimension of *legibility and information transfer* that would have a positive influence. Nurses mentioned that they feel that PDAs could help to solve information legibility problems. They perceived a lot of advantages in this situation, such as avoiding looking for a physician or medical intern that could help them to interpret a medical note, laboratory test or prescription; for not misinterpreting the information, etc. Another dimension concerning this property was the *perceived advantages of sharing information*. Nurses expressed that they perceived that when the network would be installed, it would facilitate: sharing information, access the internet, etc.

DISCUSSION

In this section we compare the findings of this study with those reported in the literature and make some suggestions for the integration process according to these.

Related to *organizational factors*, we found, as (McAlearney et al. 2004) and (Lu et al. 2005) that it is recommendable that the organization attends the aspects related to training and support, to increase the likelihood for technology to be adopted. A disadvantage of the findings that McAlearney and Lu present is that they treat these concepts in abstract; then, they leave to the reader consideration the meaning of the concepts. Thus, in the analysis performed in this study, we move further on, deepening in each of the factors found. For example, we establish the aspects needed to take into account concerning the *training program* as: place and scheduled where training sessions take place; flexibility in the time of training sessions and topics, availability of personal substitute, tailored training corresponding to the level of nurses computing experience. Also, we found that it is important that the organization offers a permanent technical support, and the technical support team to be located in a strategic place, near to technology users.

Concerning *personal factors*, we found that two of the aspects that have not been explored enough in literature are: the role that *motivation* and *stress* of the individuals play in this type of processes. For example, the findings of this study reflect that the participants feel that they are being taken into account; this can favor the adoption since they acquire a positive attitude, and this could promote more participation in the implementation process. Also, we found that the PDA's operative system language was an adoption barrier. Thus, in this case, it is important that it is taken into account; the software installed in the device must be in the native language of the subjects.

Reviewing the studies focused on adoption, we found that there exists little work that covers aspects related to *environmental factors*, in particular *characteristics of nursing practice*. The only characteristic that is taken into account is the necessity of meeting the information needs at the point of care. However, we found in this evaluation that nurses also have the need of managing information in the hallways, warehouse, nurse pavilion, etc., because they experiment a high mobility during a work shift. Therefore, in certain sense, this aspect favored the adoption of technology, because nurses could use the PDA to perform information operations whenever they need. (Ammenwerth et al. 2006) stated that it is important to consider the relationship between the subject and his/her activities (these are the *characteristics of nursing practice*); in our work we also found that this factor has a very strong influence in the adoption process; therefore we recommend to strongly emphasize on the characteristics of the work practices, such as the ones found in this study: the user's time available to experiment with new technology, perception of workload, and the priority to provide direct patient care that nurses' feel and have. It is important to try minimizing the impact generated by these characteristics as they may lead to a negative adoption, independently of the technology introduced. Concerning the priority of provide direct patient care, we suggest that the administration perform all kinds of events to promote the benefits offered by the technology and remark the tools that the nurses can use in order to provide a better patient care.

As we can see, several authors are dedicated to investigate PDAs' uses in medical environments (Fisher et al. 2003; Lu et al. 2005; McAlearney et al. 2004). However, the disadvantage that appears here is that, although they identified adoption elements, it is not defined in what stage of the integration process they are going to be present; in addition, the results obtained have not been compiled from the base of an analysis of the practical processes of adoption. In this work we introduced a boundary that enables us to identify the factors present in each stage. It is important because it enables to know the factors we need to focus on, since these are changing according to the current stage. Concerning the process integration, we stated that there exist several stages through this process: initial, training, use and future. From the experience obtained during the *use* stage, we recommend to take in consideration that the subject will go through an *adaptation* period, therefore is important to elaborate a contingency plan that contemplates: a group of substitute nurses that will provide support to participants, to balance the workload of the assigned patients and having near a technical support team in order that the nurses can clarify doubts quickly.

CONCLUSION

PDAs have significant potential to improve medical practice beyond serving as an address book or calendar. The increasing implementation of this technology is impressive, but PDAs have not yet become a standard medical tool. The qualitative study we did enabled us to identify, that there exist several critical factors that could have a positive or negative impact in the PDA adoption, such as: *organizational, environmental, informational, personal* and *technological*. Also, with the qualitative analysis we could determine in which PDA integration phase they would be present. We suggest that these factors should be considered to increase the possibility of the technology adoption to be successful.

ACKNOWLEDGMENTS

This work was partially funded by CONACYT projects 42447 and 40799 and through scholarship provided to Elisa Morán. Also we thank the participating personnel at the Hospital.

REFERENCES

1. Abraham, D. (2004) Patient Care and Safety at the Frontlines: Nurses' Experiences with Wireless Computing [Electronic version]. Retrieved on March 18, 2005 from: http://www.ibm.com/services/us/bcs/html/chm_award_patients.html
2. Ammenwerth, E., Iller, C. and Mahler, C. (2006) IT – adoption and the interaction of task, technology and individuals: a fit framework and a case study, BMC Medical Informatics and Decision Making.
3. Carroll, A. E. and Christakis, D.A. (2004) Pediatricians' use of and attitudes about personal digital assistants, Pediatrics, 113, 238 - 242.
4. Dee, C., Teolis, M. and Todd, A. (2005) Physicians' use of the personal digital assistant (PDA) in clinical decision making, Journal of the Medical Library Association (JMLA), 94(4), 480-486.
5. Courtney K., Pack, B. and Porter G. (2005) Within their grasp-hand-held computer use among registered nurses, Business Briefings: US Healthcare Strategies, 4-15.
6. Criswell, D.F. and Parchman, M.L. (2002) Handheld computer use in US family practice residency programs, *Journal of the American Medical Informatics Association (JAMIA)*, 9, 80-86.
7. Fischer, S., Stewart T., Mehta, S., Wax, R. and Lapinsky, S.E. (2003) Handheld computing in medicine, *Journal of the American Medical Informatics Association (JAMIA)*, 10, 139-149.
8. Grasso B. and Genest, R. (2001) Clinical computing: Use of a personal digital assistant in reducing medication error rates. *Psychiatr Serv* 2001; 52(7):883–884.
9. Hunter, K. (2003) Adopting mobile technology to enhance patient care [Electronic version]. Retrieved on January 15, 2004 from http://www.pdacortex.com/issues_and_attitudes.htm
10. Kleijnen, M. Ruyter, K. and Wetzels, M. (2003) Factors influencing the adoption of mobile gaming services, *Mobile Commerce: technology, theory and applications*, Idea Group Publishing, Hershey, PA.
11. Li, Y., Chang, I., Hung, W. and Fu, H. (2005) The Critical Factor Affecting Hospital Adoption of Mobile Nursing Technologies in Taiwan, *Proceedings of the 38th International Conference on System Sciences*, 2005.
12. Lu, Y., Xiao, Y., Sears, A. and Jacko, J. (2005) A review and a framework of handheld computer adoption in healthcare, *International Journal of Medical Informatics (IJMI)*, 74, 409-422.
13. McAlearney, A., Schweikhart, S. and Medow, M. (2004) Doctors' experience with handheld computers in clinical practice: qualitative study, *British Medical Journal (BMJ)*, 328, 1162.
14. Sarker,S. and Wells, J. (2003) Understanding mobile handheld device use and adoption, *Communications of the ACM*. Volume 46, Number 12 (2003), Pages 35-40
15. Strauss, A. and Corbin, J. (1998) Basics of Qualitative Research: Techniques and procedures for developing grounded theory, Sage.
16. Thong, J. (1999) An integrated model of information systems adoption in small business, *Journal of Management information systems*, 15, 4, 187 – 214.