Military Physicians' Assessments of a Mobile Medical Information System: A Longitudinal Study

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ABSTRACT

This paper sets out to investigate military physicians' perceptions and usage regarding a mobile medical information system during their military service in the Finnish Defence Forces. Longitudinal data were gathered in September and December of 2005, and April 2006 by three semi-structured surveys. The military physicians (n=31) had positive perceptions of the mobile medical system, and had used it in their daily military training. But the perceived usefulness, in the terms of effectiveness and usefulness of the system, had declined significantly in April 2006. The same trend has also been found in their perception of ease of use, in the aspect of "easy doing what I want to do". The changes of the physicians' assessments and beliefs toward the system are explained. Insights of the findings and implications for system improvement are discussed.

Keywords: mobile medical information system, usefulness, ease of use, military physicians, longitudinal study

1. INTRODUCTION

Health information technology has been adopted by military medicine in different environments and for different purposes[1]. One early adopter is the U.S. Military that is, thanks to its large resources, in the forefront of development. For example, the U.S. army medical staff has been equipped with a point-of-care handheld assistant BMIS-T (implemented on Hewlett-Packard iPAQ Pocket PCs) based on Microsoft Windows Mobile software[2]. This mobile system can help the military medics in a critical part of their job—tracking medical information on the troops under their care. The system also helps medics to make quicker and more accurate diagnoses and treatment decisions, as well as helps them to reduce the paperwork when treated personnel are moved to e.g., military hospitals. Another new electronic system, a logistic tracking system by Intermec mobile computing, lowered U.S. military drug costs by $389 million in year 2004[3]. Very recently, 3M has developed and installed an RFID-based system[4] to the U.S. Army to track medical records at the US facility in Ford Hood, Texas. These examples have shown that mobile technology is playing an increasingly important role in supporting military medicine.

However, these systems are in use in a very large organisation with massive resources. Smaller national defence forces (e.g. Finland) have generally allocated fewer resources to implement health information technologies. There are systems developed originally for civilian purposes, which could improve the efficiency of military medicine without the development cost of a tailored system. In this paper we present some insights that we have obtained from a longitudinal study by investigating the adoption and usage of a mobile medical information system among thirty one physicians during their military service in the Finnish Defence Forces from September 2005 to April 2006.The research was designed to detect the changes of the physicians' perceptions of the system, i.e. usefulness and ease of use over the time. The structure of the paper is arranged as follows: In the next section, we briefly review the relevant literature. The research method is discussed in Section 3. Results are reported in Section 4, followed by discussion and conclusion at the end of the paper.

2. LITERATURE

2.1 Theoretical Background

Users' perceptions of and intentions to adopt an information system (IS) and the rate of diffusion and penetration of technology within and across organizations are two important foci of IS research (e.g. Straub et al., 1995). Well-accepted theories, for examples, the Technology Acceptance Model (Davis et al., 1989), the UTAUT (Unified Theory of Acceptance and Use of Technology) (Venkatesh et al., 2003) have provided good explanations of the adoption and usage of technology in different socio-technical contexts. The conclusions of many studies based on these theoretical approaches have indicated that perceived usefulness and perceived ease of use are two fundamental factors determining a user's acceptance of technology. These theories have recently been applied to explain user adoption of mobile technology (e.g. Pedersen and Nysveen, 2003; Han 2005). Perceived usefulness and ease of use of a specific mobile system are also found to be important determinants of technology adoption behaviour.

There are two temporal dimensions of adoption behaviour. One is pre-adoption or initial adoption behaviour (initial adoption, first-time usage and possible rejection at the pre-implementation stage). The other is post-adoption or post-implementation behaviour, (sustained continuous usage, and discontinued usage). In the two dimensions, users usually have different beliefs regarding the technology (Karahanna et al., 1999). As users gain more experience of a system, their beliefs and attitude towards the system might change. Such changes have major impacts on human behaviour regarding continuous system usage (Bhattacherjee and Premkumar, 2004).

2.2 A Mobile Medical Information System

The mobile medical information system, investigated in this research is a set of medical information and knowledge databases. It contains doctors' handbook, the EBMG (available in both, English and Finnish) with Cochrane abstracts, pharmacology database Pharmaca Fennica with a wireless update service for a complete medicine price list, the international diagnosis code guide (ICD-10) in Finnish, a laboratory guide by the Helsinki University Hospital, an emergency care guide issued by the Meilahti Hospital, a medical dictionary of over 57,000 terms, and a comprehensive database over health-care related addresses and contact information (pharmacies, hospitals, health centres). The content of the system is generated by an XML (eXtensible Mark-up Language) database. The system functions in most mobile devices operated by different systems, e.g., Symbian, Palm OS, and Windows CE. The device most commonly used as a platform in Finland is the Nokia Communicator (9210, 9300, and 9500). The mobile medical system is delivered on a 256 MB memory card, and is self-installing, containing the search engine, user interface programs, and core databases. Currently, an update of the system is available and is delivered on memory cards. In the near future,

the system will be able to update itself partly or completely through the wireless networks. The price list, part of the Pharmaca Fennica (the pharmacopoeia) is already able to update itself through the wireless data link provided by the mobile device. The databases have been updated to include a drug interaction database originally developed by the Karolinska Institute, Sweden.

3. RESEARCH METHOD

Theories of user technology acceptance can contribute greatly to understanding user behaviour regarding technology. These theories have served as the theoretical background and generated some important concepts that we have focused on in this study. A "practice-driven" approach has been adopted to design our research due to the fact that in the early stages of studies, of an exploratory nature (like our study), it is better to conduct studies in a natural setting, rather than from a pre-established theoretical perspective (Sharker et al., 2003, Zmud, 1998).

A longitudinal study was carried out from the autumn 2005 to the spring 2006. On September 6, 2005, with support from Pfizer Finland Ltd. and Duodecim Publishing Ltd, thirty one physicians, later in this paper called military physicians, (including some medical students) undergoing their military service in the Finnish Defence Forces, were given a Nokia Communicator 9210 equipped with a mobile medical information system. After the first user training session of the system[5] (on the same day they got the system), we distributed our first, semi-structured, questionnaire to collect their demographic information and to investigate their initial perceptions of perceived usefulness and ease of use of the system. The structured measurements were borrowed from previous established research with changes in wording to make them appropriate for the mobile medical information system and the military medicine context. In December 2005, after the military physicians had used the mobile medical system for a time of approximately three months, we conducted the second survey, to study the use of the system and the opinions regarding the system being used for military purposes in the field conditions. Nineteen valuable answers were returned. In the spring 2006, these physicians were relocated to different garrisons to continue their military service. In April 2006, the third survey that had a similar structure and questions with the previous surveys was distributed. Twenty-one physicians responded the survey.

The data analysis was primarily descriptive in nature. Frequencies and some central tendencies were calculated to illustrate physicians in the military service, their usage, and assessments towards the mobile medical information system. Potential differences in their behaviour over the three points in time were tested by ANOVA (Sig. < 0.05). The Scheffé test was used for *post hoc* tests.

4. RESULTS

4.1 Demographic Information of the Study Group

Of the thirty one participants, twenty-three have graduated and have become qualified physicians, eight are still medical students. Among the 31 participants, one has earned a doctoral degree in medicine, and two have, or will, become qualified pharmacists. The gender distribution was 30 male and one female. The mean age of the group was 25.19 years, the youngest being 20 and the oldest 28. Among the participants, twenty-two have never used a Nokia Communicator (any models) prior to the first survey, eight indicated prior usage. Seven have used the mobile medical information system before; among them, two have used it for 1 year (one of the two was the female physician in the group), two have used it for some months, and 3 have tried for a few hours.

In order to know whether the participants were familiar with the contents of the databases in the mobile medical information system, we also collected information regarding the usage of Terveysportti[6], the Finnish health care portal in the Internet in the first survey. Excluding 6 missing answers, all have used it ranging from 7 months to 5 years. They have used it for education/learning purpose (n=30), for patient consultation (n=21), and for completing their specialisation knowledge (n=8).

In general, this group was young, male–dominated, and familiar with the contents of the mobile medical system.

Table 1. Usefulness of the mobile medical information system

Perceived Usefulness	Mean			F	Sig. (p<0.05)
	Sep./05 (n=31)	Dec./06 (n=19)	Apr./06 (n=21)		
Improve medical knowledge	3.97	3.68	3.62	1.18	0.313
Enhance effectiveness in the field conditions	4.34	3.94 (n=18)	3.38	7.29	0.001
Improve my ability to make good decisions	3.83	3.74	3.33	2.25	0.114
Useful	4.58	4.32	3.38	14.25	0.000

4.2 Perceived Usefulness of the Mobile Medical Information System

The military physicians' perceived usefulness of the system was studied from four aspects: (i) using the system improves my medical knowledge; (ii) using the system enhances my effectiveness to do clinical work in the field conditions; (iii) using the system improves my ability to make good decisions; and (iv) I find the system useful for me. The military physicians' evaluation was measured using a five point scale, ranging from (1) strongly disagree to (5) strongly agree.

The perceived usefulness of the system, after a period of actual usage, was still positive in general (mean value > 3), but with a clearly declining trend (Table 1) across the study period. The *F*-ratios for the analysis of variance on the aspects of effectiveness and usefulness were significant at the 5% level ($F_{effectiveness} = 7.29$, df =2, 65, $p<0.05$; $F_{useful} = 14.25$, df=2, 68, $p<0.05$). Consequently, the Scheffé Test was used to compare pairs of the means in order to assess where the differences lie. It was found that at the 5% level of significance, the assessment of effectiveness of the system in April 2006 (M=3.38) was significantly lower than those in September 2005 (M=4.34), but the means of that in September and in December 2005 did not differ from each other. The evaluation of the usefulness of the system in April 2006 (M=3.38) was also significantly lower than those in September (M= 4.58) and in December (M= 4.32), but that the means of those of the two times in 2005 did not differ from each other. A very important insight we obtain from the results is that military physicians have gradually found that the system is not very useful in their military training. As they have obtained more experience from their actual usage in the different working environments, they have evaluated the usefulness of the system quite differently from their initial hype of the system. There are several reasons. Firstly, it might be due to the differences between the civilian and military medicine. The mobile medical system is designed for civilian physicians (see Han 2005, Harkke, 2006), the contents of the system lacks of a focus on military medicine. The longer time they worked in the field conditions, the higher demand for the contents specifically suited for military medicine would be raised, and the more limitations of the current contents would be shown. The second reason may due to the fact that military physicians used the system in the tough field conditions. The weather was cold and humid during the study period. Therefore, the natural environment gave rise to the high requirements on the physical robustness of the mobile device. The Nokia communicator is not very suitable to be used in such conditions (Han et al., 2006; Tétard et al., 2006). The drawbacks of the physical device may shed a shadow on the usefulness of the system. The third reason goes to the limitation of the mobile medical system itself. As a standalone system, it contains only the medical knowledge and information, but lacks of integration with other important systems which contain some crucial information, e.g. soldiers' health records. The last reason may be the possible effect of the changing working environment from the field conditions to the garrisons after December 2005. In the different garrisons these physicians can't access to the Internet, but they have other traditional databases which are accessible, i.e. books, CDs. The possible increasing usage of the traditional databases may also lead to less use of the mobile medical system in their daily work, thus, decreased positive perceptions of it in terms of effectiveness and usefulness.

4.3 Perceived Ease of Use of the Mobile Medical Information System

The military physicians were asked to indicate their perceived ease of use of the system. Questions about four aspects were asked: (1) learning to operate the system is easy for me; (2) I find it easy to get the mobile medical system to do what I need to do; (3) It is easy for me to become skilful in using the system; and (iv) I find the system easy to use. The evaluation was measured using a five point scale, ranging from (1) strongly disagree to (5) strongly agree.

The military physicians' perceived ease of use of the mobile medical system was positive in general with most of the mean value> 4 at the three points of time (Table 2). It is interesting to notice that the evaluation has displayed an increased trend from September to December 2005, but declined afterwards, especially the aspect of "easy doing what I need to do". The *F*-ratio for the analysis of vari-

Table 2 Ease of use of the mobile medical information system

Perceived Ease of Use	Mean			F	Sig. (p<0.05)
	Sep./05 (n=31)	Dec./06 (n=19)	Apr./06 (n=21)		
Easy learning to use	4.65	4.84	4.52	1.85	0.165
Easy doing what I need to do	4.19	4.47	3.57	5.45	0.006
Easy to become skilful	4.42	4.53	4.19	1.16	0.320
Easy to use	4.32	4.42	4.05	1.38	0.258

ance was significant at the 5% level ($F = 5.45$, df = 2, 68, $p < 0.05$). The post hoc Scheffé test showed that the difference lied between the evaluations of December 2005 with that of April 2006. The changing working environment may be one of the reasons to explain the differences. In a comparison with the accessibility of the traditional databases (books, CDs), it might be not easy enough to use the mobile medical system.

4.4 Usage Behaviour

4.4.1 Usage Intention

In the first survey in September 2005, the military physicians' behavioural intention towards the system was also measured by asking, if they think they will use it in the future. There was one negative answer that indicated that the person would not use the system, several neutral responses (n=7) that indicated insecurity about the future use. Twenty-three (74.2%, n=31) military physicians expressed clear interest in using the system in the future.

4.4.2 Self-Reported Actual Usage

In the second and third survey we carried out in December 2005 and April 2006, we investigated the real usage of the mobile medical information system, in terms of usage frequency (Table 3), and volume of use during a period of one week (Table 4). The possible differences of the usage frequency and volume over the study period were performed by paired T-tests; neither of the results was statistically significant. Table 3 has shown that majority of the group have used the system on weekly basis. Two physicians have reported that they did not use it at all from the dataset in April 2006. A declined trend of usage volume was also found. As showed in Table 4, 14 physicians in April 2006, compared to 10 in December 2005 have used it less than half an hour per week. A possible explanation may go to the fact that as their hand-on experience of using the system grew, their speed to find information increased, thus, they spent less time on using it. Another explanation is the possible negative effect from their declining perceptions of usefulness of the system. Physicians do not use a system if it is not useful for their work (Jayasuriya, 1998). The third explanation may also go to the changing working environment across the study period. The increasing use of other databases would decrease the usage of the mobile medical system in terms of usage frequency and usage volume.

Table 3. Usage frequency

	Usage Frequency	
	Dec. 2005 (n=19)	Apr. 2006 (n=20)
I don't use it at all	0	2
About once a month	4	3
About once a week	4	4
Several times a week	7	8
About once a day	3	2
Several times a day	1	1

Table 4. Usage volume

	Usage Volume	
	Dec.2005 (n=19)	Apri.2006 (n=20)
< 0.5 hours	10	14
0.5-0.9 hours	6	5
1.0-1.9 hours	2	1
2.0-2.9 hours	1	0
3.0 or more hours	0	0

5. DISCUSSION

This paper investigates military physicians' perceptions on and usage of a mobile medical information system in the Finnish Defence Forces. The findings from the longitudinal study have provided us with important insights and implications.

The Military physicians have positive perceptions of the usefulness and ease use of the system, but with a declining degree, in some aspects significantly. They have used the system on a weekly basis and spent mostly less than a half an hour using it. The reasons for usage patterns presented above may give some implications for system improvement: (i) more contents of military medicine should be included into the system, such as major trauma handling, pain relief, detoxication and cleansing of chemical/radiation injury in a combat situation; hygiene, epidemiology, prevention of infectious disease outbreaks while soldiers are living under rough conditions (in field and out of casern); and some peculiarities of "military health"-mass vaccinations, epidemiology, skin disease, and occupation safety/risk issues specific for military in casern/barracks; (ii) more attention has to be paid to the mobile device which is adopted to implement the system. Measurements to increase its physical robustness in the field are required; (iii) possible integration of the system with other crucial health databases will enhance its effectiveness and usefulness for military physicians working in the field; (iv) it seems that military physicians perceptions and usage behaviour towards the system could be significantly influenced by the changing working environment. When they were not in the field they could use other information resources. The mobile system is seen primarily as a supplement to, rather than a substitute for, traditional medical databases which are delivered from wired internet, PC-based tools or in printed books.

The results from the longitudinal study and the three datasets have convinced us that such a mobile medical system is needed by military physicians, especially in the beginning of the study as well as in field conditions. However, the result from the last dataset has shown some significantly different evaluations. This may imply that in order to encourage the usage of the mobile medical system, we have to be sensitive to the physicians' working environment. In other words, the organization should strategically implement the system to the "mobile" military physicians, not to those who are stable at different garrisons.

6. CONCLUSION

This study has helped us understand how military physicians adopted a mobile medical information system during their military service, while also providing some indications of the actual usage patterns and some belief and behavioural differences across time. There seems to be a need for the kind of mobile medical system for military purposes, but some significant improvements have to be made to the civilian systems to make them fit the needs of military training and in order to increase the usage in the future.

A longitudinal study has given us the opportunity to detect more insights of the research phenomenon and also helped to reveal more important effects, such as changed working environments and temporal effects on human technology adoption behaviors.

The research reported here could be seen as a study reflecting the military physicians' reactions to mobile technology in general and the mobile medical information system in particular. Since the military physicians have used the system in their work practice, both in the field and in the garrisons, their appreciation of the system may be considered as a solid basis for future system development.

7. REFERENCES

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ENDNOTES

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5 The military physicians were given a two-hour introduction to the mobile device and the mobile medical information system.

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