Exploring the Success Factors of Electronic Health Record Systems Adoption

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Abstract--In our era with the innovations in the telecommunications and information technologies; use of e-electronic services has increased in many areas. Health is one of affected these areas by technologies. In the last decades Health Information Systems (HIS) have developed many new technologies. Telemedicine, telehealth and electronic health records can be counted as the main areas in this industry.

Health Information Systems are used by many different types of users such as patients, doctors, administration and application developers. So they all have difficulties in both using and developing these systems. This research will focus on the factors that users are affected in using the Electronic Health Record (EHR) from the technological and organizational perspective. Affecting factors of the adoption in EHR from the doctors perspective will be analyzed. Then a model will be proposed.

I. INTRODUCTION

Technology is used in many areas in health services. Medical informatics as a discipline which focuses on the data storing, processing, information and knowledge management related to the health care [14].Doctors have an important role in the adoption of health information sytems in different areas [12]. To offer a better healthcare to the patients, electronic health records are used to visualize and study on health data [14]. Future EHR system should focus on more main healthcare requirement, should look from the perspective of the patients and also would support the sharing of the information between the organizations

This research focused on to identify the main adoption factors of Electronic Health Records(EHR) diffusion by physicians.

II. LITERATURE REVIEW

International Organization of Standards defines the Electronic Health Records as EHR is a repository of information regarding the health status of a subject of care, in computer processable form' [17]. 'The term electronic health record (EHR) may be described by computerized patient record (CPR), computer-based patient record, computerized medical record, electronic medical record (EMR), electronic patient record (EPR), electronic health care record (EHCR), virtual EHR, digital medical record (DMR), automated medical record, and provider-based patient medical record. These terms were all generated from the same vision more than 30 years ago' [30].

Developments in the technology and health information systems would result to increase in the quality of healthcare [25].However with the developments in technology and telecommunications has not really improved the EHR systems [4].

EHR systems are used by different types of users such as health care professional and upper management. Moreover healthcare professionals including; physicians, nurses, radiologists, pharmacists, laboratory technicians and radiographers use different modules of EHR systems [15].

As demand of health systems stakeholders increases too much, health care providers cannot serve them until new developments have been taken in[18]. EHR systems are preferred over the paper-based records in the meaning of being portable, more accurate, easier reporting and also in some cases can be used as input for decision support systems [16].

Some models have been defined to understand the behaviors of people in the adoption process. Theory of Reasoned Actions [11], Technology Acceptance Model [8], Technology Acceptance Model 2 [28], Unified Theory of Acceptance and Use of Technology[29] can be taken as the most significant ones. Also most of the researchers are taking these models as base asset and then specify their researches on these.

Theory of Reasoned Action, which can be seen in Figure 1, takes subjective norm and attitude toward act as its main constructs. Subjective Norm refers to ' the persons beliefs that specific individuals or groups think he/she should or should not perform the behavior and his/her motivation to comply with the specific referents' [11] on the other hand, the attitude refers to 'the person's beliefs that the behavior leads to certain outcomes and his/her evaluations of these outcomes' [11].
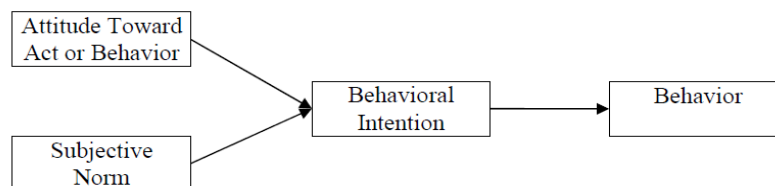

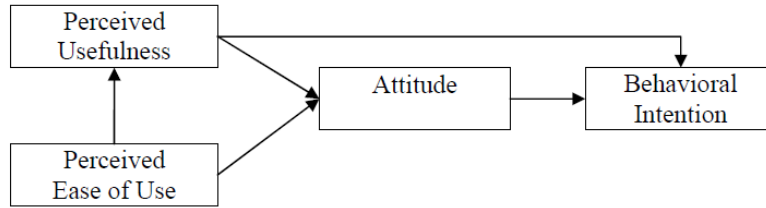Figure 1 Theory of Reasoned actions [11]

Figure 2 Technology Acceptance Model [8]

Davis came up with the idea of Technology Acceptance Model in 1989 [8]. Perceived usefulness and perceived ease of use is taking as two main drivers . In final behavioral intention bring the actual use result [8]. This model's main purpose is to predict user adoption behavior towards the technological developments.

Venkatesh and Davis has made some additions to the Technology Acceptance Model and a developed a further model with new factors in 2000.Factors such as experience and voluntariness affect the perceived usefulness. Also Perceived ease of use has determinants such as subjective norm, image, job relevance, output quality and demonstrability [28].

Unified Theory of Acceptance and Use of Technology(UTAUT) has been defined by Venkatesh et al as a combination of different adoption theories such as ; Technology acceptance model, theory of reasoned actions, theory of planned behavior [29].

UTAUT has 3 direct determinants on behavioral intention to use as; expectations from performance, expectations from effort and the influence of the social environment [29]. Intention to use and facilitating conditions affects the Use Behavior [29].

Yu et. al has extended TAM2 and proposed a taxonomy for Health IT acceptance factors. They have added subjective norm, image and computer level as antecedent factors of ease of use. Job role and subjective norm is defined as subfactors of usefulness. It's stated that Image has negative effect on the behavioral intention [32].

Further step has been on UTAUT and updated it for hospital technology acceptance. He stated that anxiety has negative effect on self efficacy. Also self efficacy has positively affects on perceived ease of use and behavioral intention [1].

Telemedicine has different adoption factors than the other technologies because its focus are is mostly the physicians and hospital administrations unlike the other technologies mostly focus on citizen, workers or students [12].
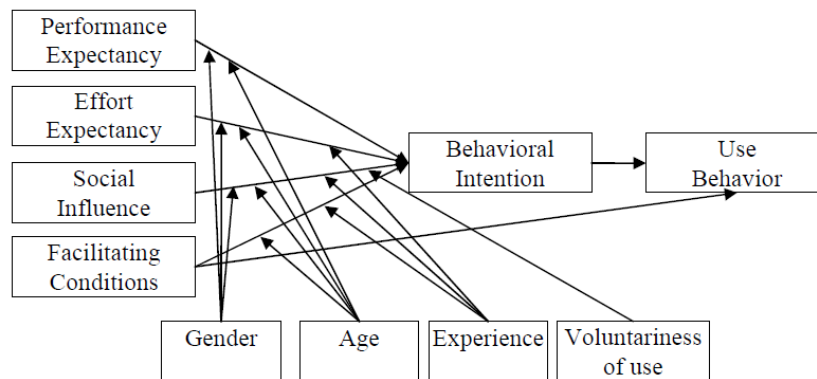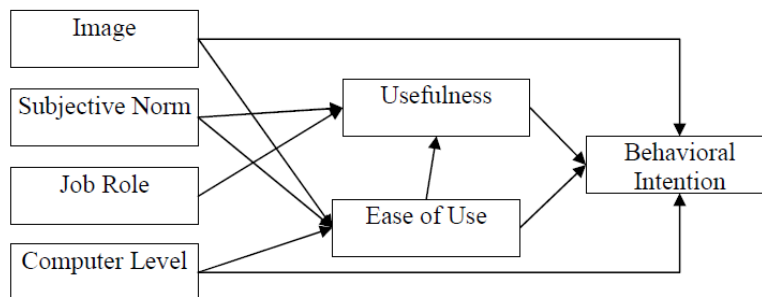
Figure 3 UTAUT [29]

Figure 4 Health IT Acceptance Factors [32]

III. METHODOLOGY

First of all we studied on literature about main technology adoption factors. Then we focused on the main factors affecting the adoption of Health Information systems. We have define main constructs and affecting factors

Then Qualitative research methodology has been chosen for the field study. Face to face semi constructed interviews has been conducted with doctors from different hospitals and branches such as gynecology, ear-nose-throat, brain surgeon and etc…

We asked them specific questions and tried to understand what are the main affecting factors of their EHR systems usage. Then we defined the factors affect on perceived ease of use and perceived usefulness.

Table 1 shows the profile of the respondents to the interview. We aimed to learn the tasks that doctors needed to achieve with EHR and also the pros and cons of the systems. Table 2 shows the questions have been asked in interview.

We included specialty of the respondents because each specialty area has different expectations from Health Information Systems. Brain surgeons mostly use the systems in order to view the X-Rays of their patients or to create their surgery reports. However pediatricians mostly use the systems for recording their diagnosis and treatments. So each doctor works on the systems with different requirements

Also many papers focused on this area has been analyzed and the main constructs have been identified. We combined our research results with the information we retrieved from the literature and developed a construct list. In this list construct gained from literature is implied by (L) and the constructs retrieved from interviews are implied as (I) in Table 3.

TABLE 1 PROFILE OF RESPONDENTS

Specialty	Age	Organization	Gender	Experience
Brain Surgeon	49	Hospital A	Male	20+
Internist	50	Hospital B	Male	20+
Pediatrician	46	Own Clinic	Male	20+
Ear-Nose-Throat	32	Hospital A	Male	6
Ear-Nose-Throat	36	Hospital C	Male	10
Pediatrician	38	Hospital C	Female	12
Dermatologist	35	Hospital C	Female	11
Pediatrician	40	Hospital C	Female	15

TABLE 2 INTERVIEW QUESTIONS

Have you ever used an Electronic Health Record System ?
Which Electronic Health Record system are you using recently ?
Can you give brief information about the activities you are handling with Electronic Health Record System you are using
Do you belive that use of EHR is mandatory ? What are you reasons?
What are the main benefits of EHR ?
What are the required functionalities that an EHR has to own ?
Are your patients aware that their records are kept digitally
Do you share electronic health records with you colleagues for consultation?
Do you keep you patients medical records by yourself or do you get help from medical assistants ?
If you let your assistants to keep your patients health records, does the complexity of the treatment/ injury affect your decision ?

TABLE 3 CONSTRUCT LIST

Search Ability (I)(L)	Job Level (L)	Access validation(L)
Complexity of the Treatment / Injury (I)	Computer Skills (L)	Auditing(L)
Medical Assistant (I)	Standardization (L) (I)	subjective norm(L)
Input Effort (L)(I)	Comparison (L)(I)	Medical History (L) (I)
Input Time (L)	Privacy (L)(I)	Data preservation(Papers can get lost) (L)(I)
Age (L)	Image (L)	Easy Access (I)
Response Time (L)	Data Migration (L)	computer skills(L)
Reporting (I)	Online Consultation (I)	Authorization (L)(I)
Statistics (I)(L)	voluntariness(L)	Provide / Patient Relations(L)
Developer Support (I)	accuracy(L)(I)	Staff Anxiety(L)
Sharing (L) (I)	Legality(L)	quality of care(L)(I)
User Interface (I) (L)	Consistency(L)	efficiency(L)
Cost (L)	reliability(L)	security(L)
Timesaving (I)(L)	Privacy(L)	disaster recovery(L)
training time(L)	Sharing (L)(I)	decision support system(L)
attitude(L)	copy(L)	decision effectiveness(L)
Subjective norm(L)	Medical Assistant (I)	

As can be seen some of the constructs have been both found in literature and survey. However some of the constructs could have just been defined in the literature. So with this research we had a chance to see the people's perspectives which could not find place in the prior literatures that we have investigated

IV. RESULTS

Constructs, which 2 or more interviewees have implied , are listed in Table 4 with their occurrence time and rate during the interviews (in total 8 interviews).

With the constructs we have gained from interviews and literature research we our proposed EHR Adoption taxonomy is implied in Figure 5.

There are intermediary factors as "ease of use" and "usefulness" which have been tested and applied and tested in many researches

Other constructs have been grouped under 3 categories as System Characteristics, Organizational Characteristics and External Factors.

A. Sharing

Easy sharing is the one of the other important factors. It is implied that unlike the paper records; medical records can be

shared easier and faster without making physical transaction such as photocopying and etc.. . [21].

Also interviewers told that sometimes they are exchanging information about patients with their colleagues. Moreover interviewers working in governmental hospitals explained that some of the governmental hospitals have been using a common system and they can easily share files through them. This also brings out that systems can be used for consultation and some EHR system can be developed with this functionality. This can also be related with the doctor's title and work experience. Because as one of the interviewers stated that

"for some specific cases I request consultation over the system from more experienced doctors. Even for some cases I share the file over the system with other departments to consult their opinion" (Brain Surgeon, 49).

Moreover it stated that many organizations started to looking for exchanging healthcare data and patient data faster through networks as a result of the development in communications technologies [27].

So easier and accurate sharing is an important adoption factor of EHR systems. It brings more flexibility than Paper based records.

TABLE 4 OCCURANCE RATE OF CONSTRUCTS

| Construct	Occurrence	Respondents	Occurrence Rate	Main Construct
User Interface	8	8	100%	EoU
Archiving	7	8	88%	Eou
Quality of Care	6	8	75%	Usefulness
Sharing	4	8	50%	Usefulness
Data Preservation	4	8	50%	EoU
Search Criteria	4	8	50%	EoU
Accuracy	3	8	38%	Usefulness
Time Saving	2	8	25%	Usefulness
Medical Assistant	2	8	25%	EoU
Standardization	2	8	25%	Usefulness
Search Ability	2	8	25%	EoU
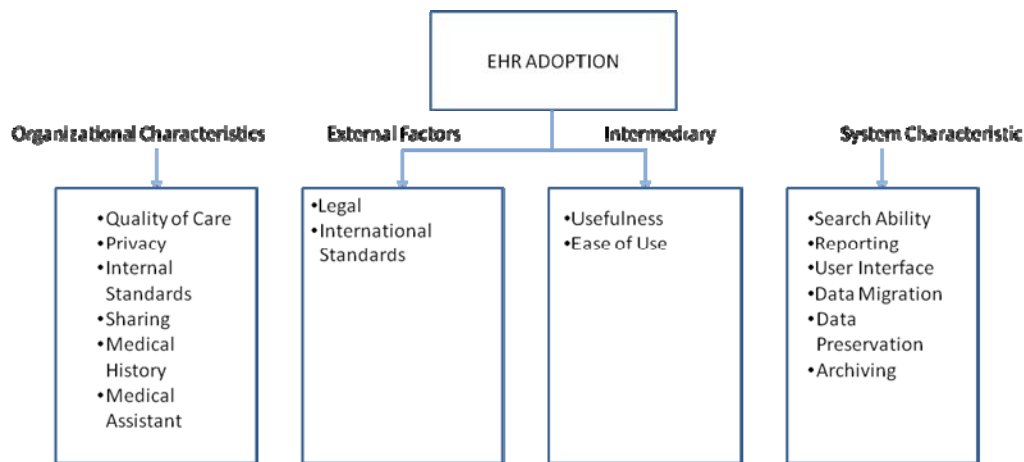
Figure 5 Proposed Taxonomy

B. User Interface

User interface highly affects the usage of EHR systems. It defines the mental operations needed to be done and also the physical steps to take for completing a task [22].

In the depth interview we made, we gained the feedback that most of the user have complaints about the UIs of the EHR systems. Some of the doctors stated that they have difficulties to compare the results of the tests that they requested with their pre-diagnoses and the patient complaints. Because all of these are kept in different places in the system and from one UI they can't view them all.

Also one of the interviewers have stated that for some tasks she need to deal with many steps.

> " For some simple tasks even I need to go to 2-3 different UIs and have to click a few buttons" (Female, 35).

User interface affects the ease of use positively. More friendly user interfaces

C. Perceived Ease Of Use

Davis defined the perceived ease of use as 'the degree to which a person believes that using a particular system would be free of effort' [8].

D. Perceived Usefulness

Perceived usefulness is defined as 'extent to which a person believes that using the system will enhance his or her job performance [8].

It is modeled that if users believe that a system has high usefulness, user will gain high performance when the system is used [8].

E. Standardization

Use of EHR brings standardization of the medical terms in the use of medical records Even though standardization of the terms may cause problems in the beginning of the adoption process, such as requiring assistance to enter standardized names, in long term users will start to use it more efficiently. Also for effective statistics standardized records are the mainly base asset [31].

One of the interviewers stated that

> " Electronic health records provide us to the chance to compare them with other patients and to be able to get statistics"(Male, Internist, 50).

Also standardization of the procedures might have a positive impact on the quality of the processes [20]. Usage of EMR has distinctive changes on the way that physicians keep their records [3]. From this standpoint we can say that getting easier Statistics with standardized information is one the important adoption factors of Electronic Health Records. We can assume that it has positive interaction with the perceived usefulness.

F. Quality Of Care

Most of our interviewees has stated that EHR usage has many affects on the quality of care provided. EHR lets user to see the medical history of the patient consistently. Physicians has access to the see past injuries of the patient and the treatments that have been applied to him/her.

If physicians do not have the enough information about the medical history of the patient they would not be able to give the right decisions. Patient care process also includes the process of getting data, turning it to information and then to use it in the decision making [7]. Keeping accurate and correct information is important otherwise with wrong data wrong clincan actions can be taken on the patients [5]. It has been proved in many studies that EHR has positive affect on the quality care.

To be able to offer a better healthcare diagnostics and treatments , healthcare providers should have good information about the patient's situation, Nowadays EHR are the upcoming as the most preferred way to keep up with patient data [13]. Also some studied have showed that with EHR input to decision support systems for some specific cases like chronic illnesses quality of care has significantly increased [6].

So we can assume that quality of care is an important factor on the usage of the EHR system. Quality of care affects the usefulness of the systems as the

G. Time Saving

As gathered from both interviews and literature, EHR usage reduces the time spent in the healthcare. Input time does not really decreases with the EHR usage but time spent for gathering the information and viewing the patient's medical history occurs much faster [9]. Also its stated sometimes data entry takes a little more time than the data entry on paper based records [24].

Our interviewees did not really give specific responses about the time that they saved during the data entry. However, they specified that EHR Usage really reduces the time spent during the search of the records and also they spend less time when they want to look for some specific information.

H. Search

Interviewees had a general opinion about that EHR has many advantages with search abilities than paper based records. Users can easily and quickly search health records over the system. In the old fashioned way doctors needed to search the files manually between folders. However as our interviewees stated EHR system are not fully functional about search now.

> "If my patients have two names it's hard to find and identify them I need another criteria to be able to search (ear-nose-throat, 32).

Also another interviewee stated that

" I can search with the name or identity number of the patient. It could be more useful if I have some other criteria(pediatrician, 38).

With the increasing data in the EHR systems search abilities will play a very critical role to find the accurate and required information [19].

We can say that search abilities are an important factor in adoption of EHR. As the search abilities are developed more it would have more effect on the use of EHR.

I. Archiving And Data Preservation

Medical records are essential for healthcare. Thus archiving plays a critical role.

> "With EHR system we gained a better archiving. We are the master of the data now. 10-15 years ago, I was giving my patients the reports, lab results and etc. about them. They needed to archive them in their house by themselves. However mostly they were not able to keep the records. They generally lost them and for next appointments they came to me without any records. So this was limiting my knowledge about the patients' background and the treatments have been applied. Now I keep all the records in my computer and the data is preserved." (Neurogiologist, 49).

One of the interviewees stated that

"Papers can always get lost even if they are stored by me or the patient itself. Archiving the records in computers are more reliable" (40, pediatrician).

Paper based records brings high costs to save,keep and then to use again. Sometimes they are transferred to different departments and sometimes they are not returned thus the data get lost [21].

Keeping the medical data is too important also for healthcare. At least the health information which can be used as input for clinical decision making should be kept and archived in systems [10]. EHR history should be recorded with its updates and also should be aimed to be kept long term as required [26].

V. CONCLUSION

Adoption to service get faster when the system meets the users' requirements. Thus this study can be taken a fundamental for the EHR system development. Developers may can take the comments of the interviews as an input for their designs.

We proposed a taxonomy within this research which will be a base for our further research. Findings show that EHR has many offerings, however users are still dissatisfied with some features. It's sure any system does not come up as fully functional and satisfies every requirement.

We found a specific iteam as Medical Asisstant. Medical assistants are the clerks in the hospital who are occupied for
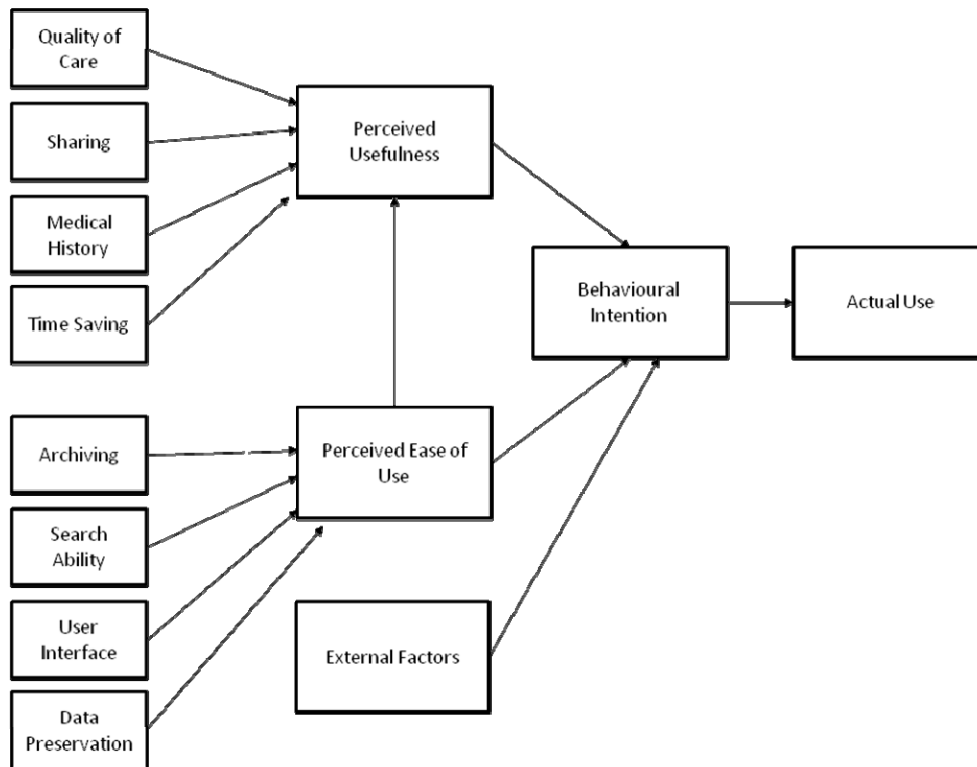

Figure 6 Proposed Model

up to 2-3 doctors. They handle the office work of the doctors. Some doctors stated that they let their medical assistants to keep their medical records

User interface, search ability, data preservation, data migration, archiving and privacy has been came the main factors of "Perceived ease of use" from the interview results.

On the other hand; quality of care, medical history, sharing and the time-saving features are the main subfactors of "Perceived Usefulness". These findings will be tested and their accuracy and weights will be defined in our further researches.

This study has some limitations. Interviews has been conducted via a small group of people (8) and most of them were employed in 2 different hospitals in Istanbul city. However we had an individual interviewee who has bought an EHR system and using it in his own clinic. Proportion of man-woman were almost close so it did not create a significant difference.

We targeted the doctors as our interview group as they are the main user of EHR systems. However there are other users of the systems such as administrations, nurses, medical assistants and other staf. These groups might also have been interviewed in future and they can be analyzed. Because their expectations and needs would have been different than the doctors.

Our proposed model has been shown in the Figure 6. This model will be tested and analyzed deeply in future researches.

REFERENCES

[1] Aggelidis, V. P., & Chatzoglou, P. D. (2009). Using a modified Technology Acceptance Model in hospitals. *International Journal of Medical Informatics* , 115-126.

[2] Bernstein, K., Bruun-Rasmussen, M., Vingtoft, S., Andersen, S. K., & Nohr, C. (2005). Modelling and Implementing Electronic Health Records in Denmark. *International Journal of Medical Informatics, 74*, 213-220.

[3] Bergman, M. J., (2007). Integrating patient questionnaire data into electronic medical records. *Best Practice & Research Clinical Rheumatology, 21(4),* 649-652

[4] Brender, J., Nohr, C., & McNair, P. (2000). Research needs and priorities in Health Informatics. *International Journal of Medical Informatics ,vol: 58-59*, 257-289.

[5] Brown, P. J.B., Warmington, V., (2002) Data quality probes*/exploiting and improving the quality of electronic patient record data and patient careender, *International Journal of Medical Informatics , 68*, 91-98.

[6] Cho, I., Kim, J., Kim, J. H., Kim, H. Y., & Kim, Y. (2010). Design and implementation of a standards-based interoperable clinical decision support architecture in the context of the Korean EHR. *International Journal of Medical Informatics , 79*, 611-622.

[7] Collins, B. & Wagner, B. (2005). Early experiences in using computerized patient record data for monitoring charting compliance,supporting quality initiatives and assisting with accurate charging at Allina Hospitals & Clinics. *International Journal of Medical Informatics , 74*, 917-925.

[8] Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information Technology. *MIS Quarterly , 13(3), 319-340.*

[9] Dobbing, C. (2001). Paperless Practice - electronic medical records at island health. *Computer Methods and Programs in Biomedicine , vol:64*, pp.197-199.

[10] Estebaranz, J.L.L., Castellano , C.V, (2009) Electronic Medical History:Experience in a Dermatology Department. *Actas Dermosifiliogr.,100, 374-385*

[11] Fishbein, M., & Ajzen, I. (1975). *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research.* Reading: MA: Addison and Wesley.

[12] Gagnon, M.-P., Godin, G., Gagne, C., Fortin, J.-P., Lamothe, L., Reinharz, D., et al. (2003). An adaptation of theory of interpersonal behaviour to the study of telemedicine adoption by physicians. *Internationl Journal of Medical Informatics ,vol: 71*, pp. 103-115.

[13] Haas, S., Wohlgemuth, S., Echizen, I., Sonehara, N., & Müller, G. (2010). Aspects of Privacy for Electronic Health Records.

[14] Haux, R. (2010). Medical Informatics: Past, present and future. *International Journal of Medical Informatics,79*, 599-610.

[15] Hayrinen, K., Saranto, K., & Nykanen, P. (2008). Definition, structure, content, use and impacts of electronic health records: A review of the research literature. *International Journal of Medical Informatics,77* ,291-304.

[16] Holbrook, A., Keshavjee, K., Troyan, S., Pray, M., & Ford, P. T. (2003). Applying methodology to electronic medical record selection. *International Journal of Medical Informatics , 70*, 43-50.

[17] International Standards Organization. (2005). *Health informatics — Electronic health record — Definition, scope, and context.* Retrieved from http://www.iso.org/iso/catalogue_detail.htm?csnumber=39525, Retrieved on 2.12.2010.

[18] Ludwick, D. A., & Doucette, J. (2009). Adopting electronic medical records in primary care:Lessons learned from health information systems bimplementation experience in seven countries. *International Journal of Medical Informatics , 78*, 22-31.

[19] Natarajan, K., Stein, D., Jain, S., & Elhadad, N. (2010). An analysis of clinical queries in an electronic health record search utility. *International Journal of Medical Informatics , 79*, 515-522.

[20] Nowinski, C. J et al., (2007). The impact of converting to an electronic health record onorganizational culture and quality improvement. *International Journal of Medical Informatics , 76(S)*,S174-S183.

[21] Safran, C., & Golderberg, H. (2000). Electronic patient records and the impact of the Internet. *International Journal of Medical Informatics* , 77-83.

[22] Saitwal, H., Xuan, F., Walji, M., Patel, V., & Zhang, J. (2010). Assessing Performance of an Electronic Health Records (EHR) using Cognitive Task Analysis. *International Journal of Medical Informatics , 79*, 501-506.

[23] Scott, R. E. (2007). e-Records in health - Preserving Our Future. *International Journal of Medical Informatics , 76*, 427-431.

[24] Shabbir, A. S., Ahmet, L. A., Sudhir, R. R., Scholl, J., Li, Y.-C., & Liou, D.-M. (2010). Comparison of documentation time between an electronic and a paper-based record system by optometrists at an eye hospital in south India: A time–motion study. *Computer Methods and Programs in BioMedicine , 100*, 283-288.

[25] Tange, H. J., Hasman, A., Robbe, P. F., & Schouten, H. C. (1997). Medical Narrative in Electronic Medical Records. *International Journal of Medical Informatics , 46*, 7-29.

[26] Toyoda, K. (1998).Standardization and security for the EMR. *International Journal of Medical Informatics , 48*, 57-60.

[27] Ueckert, F., Maximilian, A., Goerz, M., Tessmann, S., & Prokosch, H. U. (2003). Empowerment of patients and communication with health care professionals through an electronic health record. *70*, 99-108.

[28] Venkatesh, V., & Davis, F. D. (2000). A Theoritical Extension of the Technology Acceptance Model : Four Longitudinal Field Studies. *Management Science , 46* (2), 186-204.

[29] Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. (2003). User Acceptance of Information Technology: A Unified View. *MIS Quarterly , 27*, 425-478.

[30] Wen, H.-C., Ho, Y.-S., Wen-Shan, J., Li, H.-C., & Hsu, Y.-H. E. (2007). Scientific production of electronic health record research, 1991-2005., vol. *86*, pp. 191-196.

[31] Yoshihara, H. (1998). Development of the Electronic Health Record in Japan. *International Journal Of Medical Informatics*,vol. 48, pp. 53-58.

[32] Yu, P., Li, H., & Gagnon, M.-P. (2009). Health IT acceptance factors in long-term care facilities: A cross-sectional survey. *International Journal of Medical Informatics , 78*, 219-229.