Faculty of Information and Communication Technology

THE IMPACT OF USER INTERFACE DESIGN ELEMENT FOR DOCTOR SATISFACTION ON ELECTRONIC MEDICAL RECORD SYSTEM

Nuur Farhana Shatilah Bt Zakaria

Master of Science in Information and Communication Technology

2016

© Universiti Teknikal Malaysia Melaka

THE IMPACT OF USER INTERFACE DESIGN ELEMENT FOR DOCTOR SATISFACTION ON ELECTRONIC MEDICAL RECORD SYSTEM

NUUR FARHANA SHATILAH BT ZAKARIA

A thesis submitted
in fulfilment of the requirements for the degree of Master of Science
In Information and Communication Technology

Faculty of Information and Communication Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2016

© Universiti Teknikal Malaysia Melaka

DECLARATION

I declare that this thesis entitle “The Impact of User Interface Design Element for Doctor Satisfaction on Electronic Medical Record System” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and not concurrently submitted in candidature of any other degree.

Signature : .....

Name : .....

Date : .....

© Universiti Teknikal Malaysia Melaka

APPROVAL

I hereby declare that I have read this thesis and in my opinion, this thesis is sufficient in term of scope and quality for the award of Master of Science in Information and Communication Technology.

Signature : .....

Supervisor Name : .....

Date : .....

© Universiti Teknikal Malaysia Melaka

DEDICATION

Hi, Ibu & Ayah!

wave

© Universiti Teknikal Malaysia Melaka

ABSTRACT

The user interface has slowly become one of the primary reasons for the users to refuse to use the electronic medical record (EMR) system even in a forceful way. The interface design not only affecting the daily tasks, but also patient-doctor relationship. This research is aimed to produce a validated user interface design of an EMR system. In order to understand the problems, it is best to know the user requirement versus real required demand for both EMR system and user interface design. Most of EMR system that develops nowadays were designed based on developer imagination and senior doctors as an advisor (system requirement) but not based on current technology and young doctor's opinion. It is often mentioned that opinion from experience user is the best, but the results prove otherwise especially in user interface design. A number of 93 participants of future doctors from MMMC, medical staffs from UTeM Clinic and 1PHRS a BIOCORE health care system participate in this research.Therefore, the user requirement of the system funtion is gained from an experience doctor and young doctor by using the participitory approach.The new idea is acceptable but the doctor refuse to make changes in their current system because they require more time to adapt to the changes and this idea are not yet implemented in the working system.Hopefully, the proposed interface can improve the patient-doctor relationship and ease the daily tasks.

© Universiti Teknikal Malaysia Melaka

ABSTRAK

Antara muka pengguna telah perlahan-lahan menjadi salah satu sebab utama pengguna enggan menggunakan sistem rekod perubatan elektronik (EMR) walaupun dalam keadaan terpaksa.Reka bentuk bukan sahaja memberi kesan kepada rutin harian, tetapi juga hubungan pesakit-doktor. Kajian ini bertujuan untuk menghasilkan reka bentuk antara muka pengguna yang diperakui sistem EMR. Bagi memahami masalah tersebut, adalah lebih baik untuk mengetahui keperluan berbanding kehendak pengguna untuk keperluan sistem dan antara muka berserta keperluan tentang antara muka. Kebanyakan sistem EMR yang dibangunkan pada masa kini telah direka berdasarkan imaginasi pereka dan doktor kanan tetapi tidak mengambilkira teknologi semasa dan pendapat daripada doktor muda. Pendapat daripada penguna yang pengalaman sering disebut sebagai yang terbaik, tetapi hasil keputusan kajian membuktikan sebaliknya terutamanya aspek reka bentuk antara muka pengguna. Sejumlah 93 peserta bakal doktor dari MMMC, kakitangan perubatan dari Klinik UTeM dan sistem penjagaan kesihatan 1PHRS dari BIOCORE telah terlibat dalam kajian ini. Oleh itu, keperluan pengguna terhadap fungsi sistem ini adalah daripada doktor yang berpengalaman dan doktor muda dengan menggunakan kaedah penglibatan secara langsung. Idea baharu ini boleh diterima tetapi doktor tidak mahu melakukan perubahan pada sistem yang sedia ada kerana mereka memerlukan lebih masa untuk mengadaptasi pada perubahan tersebut. Antara muka yang dicadangkan ini mampu untuk menambahbaik hubungan antara pesakit-doktor dan memudahkan tugas seharian doktor.

© Universiti Teknikal Malaysia Melaka

ACKNOWLEDGEMENT

"In the name of Allah, the most gracious, the most merciful."

I am thankful to Allah for everything, the good and the bad and everything in between that were necessary to complete this disquisition.

I would like to express my sincere acknowledgment to my supervisor Associate Professor Dr. Mohd Khanapi Abd Ghani for the useful comments, remarks and engagement through the learning process of this master thesis.

Special thanks go to all the lab's members of the BIOCORE and OptiMASS for the support. I would like to thank all the participants, who have willingly shared their precious knowledge. I greatly value my loved ones, who have supported me throughout all these year by helped me stay sane. Finally, I thank my parents for supporting me throughout all my studies at university.

© Universiti Teknikal Malaysia Melaka

TABLE OF CONTENTS

		PAGE
DECLARATION		
APPROVAL		
DEDICATION		
ABSTRACT		**i**
ABSTRAK		**ii**
ACKNOWLEDGEMENT		**iii**
TABLE OF CONTENTS		**iv**
LIST OF TABLES		**vii**
LIST OF FIGURES		**ix**
LIST OF ABBREVIATIONS		**xii**
LIST OF APPENDICES		**xiii**
LIST OF RELATED PUBLICATIONS		**xiv**
CHAPTER		
1.	**INTRODUCTION**	**1**
1.1	Overview	1
1.2	Project Background	1
1.3	Problem Statements	3
1.4	Research Questions	5
1.5	Research Objectives	6
1.5.1	Review and compare	6
1.5.2	Conduct primary data collection	6
1.5.3	Design and develop EMR user interface	6
1.5.4	Validate and test prototype	7
1.6	Research Significant	7
1.7	Summary	8
2.	**LITERATURE REVIEW**	**9**
2.1	Introduction	9
2.1.1	Medical Records and Electronic Medical Records	10
2.1.2	Healthcare in Malaysia	12
2.2	Identified Problems in EMR	13
2.3	User Interface Design	18
2.3.1	A comparison of paper and screen	19
2.4	User interface in EMR	21
2.4.1	User interface elements	22
2.4.2	User interface principles	25
2.4.3	User requirements	27
2.4.4	System requirements	27
2.5	Evaluating of EMR System	28
2.5.1	Tange et al. 1997	29
2.5.2	Nygren 1997	30

© Universiti Teknikal Malaysia Melaka

2.5.3 Marcus et al. 2000 31
2.5.4 Rose et al. 2005 32
2.5.5 Johnson and Turley 2006 33
2.5.6 Zheng, Padman & Johnson 2007 34
2.5.7 Chen & Akay 2011 35
2.5.8 Larkin & Kelliher 2011 37
2.5.9 Salman et al. 2012 38
2.5.10 Ilie et al. 2013 40
2.6 Case study 41
2.6.1 1Personalised Health Record System (1PHRS) 41
2.6.2 Universiti Teknikal Malaysia Melaka Clinic (UTeM Clinic) 45
2.7 Discussion 48
2.8 Summary 50

3. METHODOLOGY 51
3.1 Introduction 51
3.2 Analysis 53
3.2.1 Case Study 53
3.2.2 Problem Statement 55
3.2.3 Literature Review 56
3.2.4 Research EMR Interface 59
3.3 Design 59
3.3.1 Questionnaire 61
3.3.2 Interview 66
3.3.3 1PHRS Prototype 67
3.4 Development 68
3.5 Validate and Test 70
3.6 Summary 71

4. AN ANALYSIS OF USER INTERFACE DESIGN FOR EMR: A CASE STUDY 72
4.1 Introduction 72
4.2 Case Study 72
4.2.1 Melaka Manipal Medical College 73
4.2.2 UTeM Clinic 73
4.2.3 1PHRS prototype 74
4.3 Data Collection 74
4.3.1 Descriptive method (MMMC) 74
4.3.2 Reliability (MMMC) 87
4.3.3 Interview 89
4.4 Discussion 93
4.4.1 Analysis of collected data 93
4.4.2 Analysis of user interface requirement 95
4.5 Summary 101

© Universiti Teknikal Malaysia Melaka

5. DEVELOPMENT OF ELECTRONIC MEDICAL RECORD USER INTERFACE (EMRUI) DESIGN 102
5.1 Introduction 102
5.2 Prototype 102
5.2.1 Interface elements 103
5.3 Final Prototype 108
5.3.1 System module 108
5.3.2 Interface elements 109
5.4 Summary 111

6. VALIDATING THE DESIGN 112
6.1 Introduction 112
6.2 Validation Approach 113
6.3 Summary of Validation Results 113
6.3.1 Validation of system requirements 113
6.3.2 Validation of user interface 121
6.3.3 Validation of screen design 125
6.4 Discussion 128
6.5 Summary 131

7. SUMMARY AND CONCLUSION 132
7.1 Introduction 132
7.2 Concluding Remarks 132
7.3 Research Contributions 133
7.4 Future Work 136
7.5 Conclusion 137

REFERENCES 138
APPENDICES 156

© Universiti Teknikal Malaysia Melaka

LIST OF TABLES

TABLE	TITLE	PAGE
2.1	List of EMR problems	17
2.2	Summary of EMR system	29
3.1	Meeting session with doctor and pharmacist at UTeM Clinic	55
3.2	Mix-method Procedures for an exploratory instrument	60
3.3	Summary of research methodology	71
4.1	Age	76
4.2	Gender	76
4.3	Handedness vs. System Type	82
4.4	Screen Layout vs. System Type	83
4.5	Information Layout * System Type	85
4.6	Menu Selection * System Type	86
4.7	Multi-item statement to measure medical participants expectation of EMR	88
4.8	Cronbach's Alpha Reliability	89
4.9	Interview Questions	89
4.10	PhIS interview question	91
6.1	Icon familiarity	115
6.2	Acknowledge of menu/function at fixed location	120
6.3	Acknowledge by using blue warm as system theme	121
6.4	Terminology usage in the system	121

© Universiti Teknikal Malaysia Melaka

6.5	Questions use to measure medical participant's interaction of EMRUI	122
6.6	Interaction time from left, right, top and bottom of screen	127
6.7	Interaction time for confirm button	128
7.1	Functional & non-functional requirement from UTeM Clinic	169

© Universiti Teknikal Malaysia Melaka

LIST OF FIGURES

FIGURE	TITLE	PAGE
2.1	EMRUI design	10
2.2	Classified problems in EMR system	13
2.3	Elements to design EMR interface	22
2.4	Elements of UI	23
2.5	User interface principles	25
2.6	Wireframe proposed by (Rose et al. 2005)	32
2.7	Original screen before transfer into website	34
2.8	Main features and overall frequency of access	35
2.9	AID's Module	36
2.10	Propose user interface for AID	36
2.11	Example of input-based interface	37
2.12	Task for emergency medical information system	39
2.13	Emergency department wireframe	40
2.14	1PHRS workflow	42
2.15	Pharmacy previous and current interface	44
2.16	Scenario of consultation at UTeM Clinic	47
2.17	EMRUI Design elements	49
3.1	An overview of research design	52
3.2	The tree diagram of literature review process	58

© Universiti Teknikal Malaysia Melaka

3.3	Flow of Questionnaire	61
3.4	Method to get preliminary design	68
3.5	Flow of design EMRUI design	68
4.1	Summary of case study	72
4.2	Frequency for gender & age	75
4.3	Frequency of handedness	77
4.4	Frequency of system type	77
4.5	Frequency for screen layout	78
4.6	Frequency for information layout	79
4.7	Result Analysis Main Selection	79
4.8	Result Analysis Number of Colour	80
4.9	Result Analysis Colour Type	81
4.10	Correlation between handedness & system type	82
4.11	Correlation between screen layout & system type	83
4.12	Correlation between information layout & system type	84
4.13	Correlation between main selection & system type	86
4.14	Summary by gender	93
4.15	Screen layout	94
4.16	Information layout	94
4.17	Method to gain multiple results	97
4.18	Prototype results by participant selected	98
4.19	Prototype results by mix-match method	100
5.1	Font icons	104
5.2	Final wireframe of EMRUI	107
5.3	EMRUI prototype	108

© Universiti Teknikal Malaysia Melaka

5.4	EMRUI main menu page	109
5.5	Accordion with green button	110
5.6	Field for date in EMRUI	111
6.1	Information attribute during new registration	116
6.2	Attribute for patient information	117
6.3	Important attribute for vital signs	118
6.4	Role of capture vital sign	119
6.5	Preferable SOAP	120
6.6	Percentage of interaction	123
6.7	Experiment for menu interaction	126
6.8	Experiment for confirm button	126

© Universiti Teknikal Malaysia Melaka

LIST OF ABBREVIATIONS

EMR	Electronic Medical Record
EHR	Electronic Health Record
MOHM	Ministry of Health Malaysia
IT	Information Technology
LHR	Lifetime Health Record
THIS	Total Hospital Information System
HIPPA	Health Insurance Portability and Accountability Act of 1996
MMC	Malaysia Medical Council
HCI	Human Computer Interaction
UX	User Experience
IS	Information System
EHR	Electronic Health Record
US	United State
HL 7 CDA	Health Level 7 Clinical Document Architecture
UTeM	Universiti Teknikal Malaysia Melaka

© Universiti Teknikal Malaysia Melaka

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Interview questions	153
B	Cronbach's alpha in MMMC Chapter 4	156
C	Cronbach's alpha for interaction validation Chapter 6	161
D	Interface of EMRUI model	163

© Universiti Teknikal Malaysia Melaka

LIST OF RELATED PUBLICATIONS

No.	Publications	Related Chapter
	Journal (1)	
1.	Shatilah Zakaria, Ghani M.K.A., 2014. Analysis of EMR User Interface Requirement by Medical Student. *Journal of Theoretical and Applied Information Technology*, 69(3).	4 and 5
	Conference (1)	
1.	Zakaria, S. and Ghani, M.K.A., 2013. The Impact of EMR User Interface Design on Doctor Satisfaction. *e-Proceeding of Software Engineering Postgraduates Workshop (SEPoW)*, p.94.	1

© Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

1.1 Overview

The overall aim of the research is to produce a validated user interface design for an electronic medical record (EMR) system. The proposed user interface for EMR should provide an effective interface that could assist the doctors in using the EMR system without feeling offense and jeopardize.

The design of the user interface should admit the principles of user interface design, the trend in designing an interface, human coordination and many others (Horsky et al. 2012). This research focus on user interface design for EMR and its impact on doctor satisfaction.

1.2 Project Background

EMR is a computer system that is focusing on patients that contain patient information such as patient's conditions and medication history. Medical history is a medical records (Tamersoy et al. 2012) that alleviate the improvement of health care quality, efficiency and safety. Health care quality has been an important subject to the Ministry of Health (MOH) Malaysia for many years. One of the first steps done by MOH is to increase

© Universiti Teknikal Malaysia Melaka

the quality of healthcare in Malaysia is through Telehealth project. The operations of Health Information Management System (HIMS) for MOH has begun since the year 1980 and over the years, the programs have reviewed their requirements to accommodate returns for new programs and activities. Early information technology (IT) in Malaysia already begun between in the year 1991 and 1995. Implementation of the telehealth project in Malaysia is beginning at the Selayang Hospital in the year 1999, followed by the Putrajaya Hospital in the year 2000. The implementation indeed designed for to handle administrative tasks in the healthcare facilities, to have a good management of drug inventory, and to help the health services in managing their information reporting. EMR can dramatically shift the work of a doctor with a few taps on a keyboard. A doctor can call up all of the office notes on a patient as well as reports from specialists, test results, family history, and lists of past treatment and medication. As well as can sent the prescription to the pharmacy.

The shifts of paper to the screen have some consequences that need to be considered before the designing the interface. We need to realize this to avoid making things that were comfortable with the paper getting more difficult in the computerized media. According to the Sittig et al.(2008) and Ng (2014) data representations should be rich in information content, elaborated and optimized for fast information extraction. Medical concept representation is not only a matter of words and terminology, but there is also a need for the development of representations that provide overviews in some particular frequently encountered decision-making situations. Other than that, it is also important to be able to exploit the possibilities for enhancement of human cognitive skills, such as using dynamical pictorial representations, colours, symbols, and other visual codes (Tange, Hasman, Robbe and Schouten 1997; Garrard 2000; Sutcliffe, Fickas and Ehlhardt, McKay Moore Sohlberg 2003).

© Universiti Teknikal Malaysia Melaka

According to Wakefield et al.(2010), Ilie, Turel and Witman (2013), Alsos, Das and Svanæs (2012), and Goldzweig, Towfigh, Maglione and G.Shekelle (2009), there are many issues related to financial, implementation, system modules and user interface that cause the users reluctant to use. The implementation of both MOH also faced negative consequence when the system that were handled by the vendor is not capable to manage data integration. The integration issues not only occur to the Selayang Hospital but also to the Putrajaya Hospital when the system unable to do external data integration (K.Noraziani et al. 2013). User interface issues are the most common reason, even though, many solutions have been suggested, but the mistakes still keep on recurring that causes the doctor reluctant to apply the system.

1.3 Problem Statements

Poor user interface design has been pointed out as a factor contributing directly to the problems of computerized medical records (Tsumoto 2003; Laily 2003; Nygren 1997). It has become the main reason the doctors reluctant to use a computer in recording clinical finding. Most of the problems occur in EMR related to user interaction and design of the user interface.

Simplicity adoption is critical for screen reading because the process of screen reading is different compared to reading from paper-based. By transferring items precisely from paper sometimes could help the user in term of familiarity, but at the same time could slow down the process. Especially when it requires the user to fill in all information using keystrokes. Some of the identify problems are doctor need more time to select input control components such as drop-down and checkbox components compare to the writing process. Not merely that, the user also took a longer time to fill in the text field, especially when the system interface asks the user to fill in more data. Using excessive user interface component

© Universiti Teknikal Malaysia Melaka

in single screen also has been identified as one of the major problems because the paperless concept has forced the user to capture all unnecessary information.

Consistency in the user interface is an effective way to increase the speed of target recognition, and it should apply to the font, colour, and placement of user interface components. For example, login screen, main menu screen, and other modules should have the same background colour and layout fields. However, there still inconsistent in the arrangement of screen layout for every navigate screen, inconsistent with placement and usage of components that includes the way text field are used.

Currently, the developed medical system does not provide users with intuitive user interface. Most users nevertheless prefer to focus on the outcomes of the system but not the process as most developers think. It is important to design the user interface that uses intuitive because a good user interface can make the user feel friendly toward the system. Still, most systems that are developing nowadays is more to system-oriented. System oriented are a system that follow exactly like the flowchart process with ‘yes’ and ‘no’ or more to not human way. EMR is a system that needs to fulfil organization guideline tasks, but if developer push aside the importance of user friendly interface, the users will not value the system. Well-designed and usable interfaces for medical record systems essential to permit more effective and reliable data entry (Zheng, Padman, Johnson and Diamond 2007).

Numerous end users of medical data systems have a bad experience with the usability of the interfaces in medical record system such as learnability, flexibility, and robustness (Salman, Cheng and Patterson 2012). A system ought to be efficient in solving the problems faced by users, in a manner that is satisfying them. Although user requirements are the most significant basis for system development, fulfilling only client prerequisites is insufficient to create a usable system (Marcus et al. 2000).

© Universiti Teknikal Malaysia Melaka

1.4 Research Questions

After a series of review and discussion on the user interface for EMR, there are crucial issues that can be scope out from the literature. Most EMR systems of other countries started to standardise their module such as consultation and pharmacy module. From the same idea of standardising, the user interface could also be used as a reference to the interface design in EMR. Because not all human is the same in the way of thinking and physical, the interface should be developed to the majority's satisfaction. Questions related to the study are as below.

1. *What is the crucial design factor that could make the user interface usable to be used by the doctor?*

This question is related to the element of the user interface design, the principles of user interface and what are the correct design that could be use to satisfy the doctor. The medical business flow is different from typical business or user interface because it could affect the doctor-patient relationship. Therefore, many principles of designing an interface should be count. From the research in usability engineering, we know that the five essential usability characteristics that are vital for any Human–Computer Interaction (HCI). These attributes are not easy to accomplish, particularly when one needs to manage as heterogeneous user group as in healthcare (Herzberg et al. 2009).

2. *What type of user interface design that suitable for healthcare field?*

This research question is linked with a preferable user interface in the healthcare field. The survey shall be performed to know their preference in the user interface and it should focus more on younger age group. The question should related to user interface layout and the component that they familiar. Perhaps we can expose the trait of user preferable interface design by involving the user at the design stage.

© Universiti Teknikal Malaysia Melaka