Exploring New Factors and The Question of ‘Which’ in User Acceptance Studies of Healthcare Software

Noor Azizah KS Mohamadali, MSc.

Thesis submitted to the University of Nottingham
for the degree of Doctor of Philosophy

School of Computer Science
The University of Nottingham
United Kingdom

September 2012

Abstract

The importance of user acceptance of technology is critical for the success of technology implementation in the health-care sector. Spending on the procurement of new technology is growing in the hope of improving patient care as well as providing better services to the public, thus it is important that the technology is used to achieve its intended purpose. Success or failure of technology implementation depends upon the acceptance of the user and this is evident through the growing number of studies on evaluation particularly on user acceptance of the technology. While various models and frameworks have been developed to address factors associated with technology acceptance, they provide little understanding on the reasons for discrepancies in acceptance of the same system among different users. In response to this issue, this thesis proposes a theoretical model which suggests the role of 'fit' between user, technology and organization as an antecedent of user acceptance factors. This model was suggested based on a review of the literature and was empirically investigated on medical students' intention to use medically related software.

The proposed model in this thesis integrates three very well known existing models namely the Unified Theory of Acceptance and Use of Technology (UTAUT), the DeLone McLean IS Success Model and the Task-Technology Fit Model. The model is examined as a single model, which investigates (1) the effect of perceived fit between user, technology and organization on factors defined by UTAUT and the IS Success Model; (2) the effect of perceived fit between user, technology and organization on management support and information security expectancy construct; and (3) the effect of management support and information security expectancy on intention to use.

In particular, this thesis seeks to investigate the role of ‘fit’ between user, technology and organization variable as an antecedent of performance expectancy, effort expectancy, social influence, facilitating conditions, software quality, service quality, information quality, management support and information security expectancy. This thesis also investigates the role of management support and information security expectancy constructs on intention to use which, to the best of researcher’s knowledge, have not been investigated together with an integrated model, as proposed in this thesis. Further, it presents and discusses empirical findings from the Internet survey and Drop-off approaches of 113 respondents which examined students’ intention to use medically related software using the Partial Least Square (PLS) approach to Structural Equation Modeling (SEM). WarpPLS version 3.0 software was used to analyze the empirical data in this thesis. The findings of this thesis support the hypothesized relationship proposed in the theoretical model. Specifically, the results revealed that perceived user-technology-organization fit has a significant effect on all the factors defined in the model except for social influence. The results also provide strong evidence of the relationships between the management support and information security expectancy constructs with the intention to use construct.

This thesis contributes to theoretical and practical knowledge by providing, for the first time, evidence about the relationship between perceived user-technology-organization fit with constructs defined by both UTAUT and the IS Success Model. Further, the relationships between perceived user-technology-organization fit with management support and information security constructs are shown. Additionally this thesis provides empirical support on the relationship between the management support and information security expectancy constructs with the intention to use construct. The introduction and inclusion of organization fit with user and technology fit contributes to the body of knowledge in evaluation studies and provides a more complete model within user acceptance studies to help to understand the reasons for different acceptance among users of the same system or technology.

Further, this thesis investigates the applicability of the multi-criteria decision analysis (MCDA) techniques to answer the question of 'which' in evaluation studies particularly within user acceptance studies. Existing evaluation studies provide the means to answer the question of what, why, who, when and how, but not explicitly the question of 'which'. The question of 'which' needs to be explicitly addressed and specifically recognized in user acceptance studies. Although various studies implicitly provide the answer to the question of 'which', the importance of 'which' as the most critical factor or the most influential factor should be addressed explicitly in user acceptance studies. This thesis examined three well used methods which are classical AHP, Fuzzy AHP Changs' method and Fuzzy AHP α and λ method, to assign weights between various factors and sub-factors of user acceptance. Acceptance factors of two different types of software were computed using each of these methods. The empirical data were collected from medical students for medically-related software and from research students for research-related software.

The approaches examined, in this second part of thesis, are not intended to show which is the best method or techniques to evaluate user acceptance, but rather to illustrate the various options which are available within MCDA approaches to derive weights among evaluation items and subsequently provide an answer to address the question of 'which' explicitly within user acceptance studies. The results of assigning weights to factors and sub-factors using three different methods provide strong justification on the applicability of the MCDA methods as a decision support tool. The results show that these methods produced the same ranking of the factors which influence user acceptance (with slight variation using Fuzzy Chang's method on medical software acceptance). The inclusion of the 'which' question can enhance evaluation studies in the health informatics research and findings related to user acceptance of health-care technology.

Declaration

The work in this thesis is based on research carried out at the *Intelligent Modelling and Analysis* (originally, the *Automated Scheduling, Optimisation and Planning*) Research Group, the School of Computer Science, the University of Nottingham, England. No part of this thesis has been submitted elsewhere for any other degree or qualification and it all my own work unless referenced to the contrary in the text.

Dedication

To the memory of my beloved, respected and greatly missed father, **Allahyarham Haji Mohamadali bin Syed Abdul Kadir**.

With love and pride...

To my mother, Aminah Mohd Shariff

To my husband, Sheik Abdullah Mohamed Shahabudden

To my parents-in-law, Mohamed Shahabudeen and Shahjahan Beevi

To my daughters, Noor Afreena and Noor Asifa.

Acknowledgements

Alhamdullilah hi Robbil Allamin to Allah, the Al-Mighty, the Most Beneficient and the Most Merciful who made this journey possible by granting me the patient, the courage and the strength. Without His blessing this journey would not be possible, alhamdullilah.

I would like to offer my sincerest gratitude to my supervisor, Professor Jon Garibaldi for providing continuous support, guidance and knowledge throughout this research programme.

I also would like to thank Professor Ramayah Thurasamy from University of Science Malaysia (USM) for his valuable help and advice especially in the statistical aspect of the data analyses.

I would like to thank many of my colleagues and friends from the Intelligent Modelling and Analysis (IMA) and Automated, Scheduling and Planning (ASAP) research groups at the University of Nottingham. In particular I would like to thank Dr. Daniele Soria for his advices and help with my thesis.

I am also thankful for the help given to me by students from Leicester University who helped to distribute and participated in my survey.

Special thanks to Erni Yentti Amir for her countless help in taking care of my kids and always being around whenever I need help, cannot thank you enough.

Above all, I would like to thank my husband, Sheik Abdullah Mohamed Shahabuden, for his personal support and great patience to me and my daughters. Huge thanks to both of my daughter, Noor Afreena and Noor Asifa for their love, especially their patient and understanding whenever I am ‘down’ with my work.

Thanks to my mother, to my sisters and brother and all their families, and to my parent in-law for their support and encouragement throughout my PhD study.

To my dad, KS Mohamadali who passed away on 18th February 2011, all my success will not be possible without your support and encouragement, to create a person who I am now, to always be there whenever I need, to cherish me with all your love, who I wished to be with me to witness my success and I believe you always be there for me.

Finally, I would like extend my gratitude to my employer, International Islamic University Malaysia (IIUM) and to the government of Malaysia for funding me during the course of my doctoral studies.

Glossory

TRA	Theory of Reasoned Action
TRB	Theory of Planned Behavior
TAM	technology Acceptance Model
UTAUT	Unified Theory of Acceptance and Use of Technology
FITT	Fit between Individual, Task and Technology
P-O Fit	Person-Organization Fit
TTF	Task-technology Fit
PUTOF	Perceived user-technikigy-organization fit
PE	Performance Expectany
EE	Effort Expectancy
FC	Facilitating Condition
SWQ	Software Quality
SERQ	Service Quality
MS	Management Support
ISE	Information Security Expectancy
CFA	Confirmatory Factor Analysis
SEM	Structural Equation Modelling
PLS	Partial Least Squares
MCDA	Multi-criteria Decision Analysis
AHP	Analytic Hierarchy Process
AVE	Average Variance Extract
CR	Consistency Ratio

Contents

List of Figures

List of Tables

Chapter 1

Introduction

Chapter 1 gives an introduction on the scope of research in this thesis. Section 1.1 outlines a discussion of the background and motivation for this research in Section 1.1. Section 1.2 presents the research problems, identifies and formulates the research questions in order to achieve the objectives of this research. The methodology used in this thesis is briefly discussed in Section 1.4. An outline of the thesis organization is outlined in Section 1.5. Finally, the contribution made by this thesis is illustrated in Section 1.6.

1.1 Background and Motivation

Medical Informatics (MI) or Health Informatics is a scientific field that focuses on realizing the potential use of computers in the health care sector. It is a multi-disciplinary area that involves the application of multiple information sciences within the medical domain. This field of medical informatics was identified as a new specialty in the 1970s. As noted by Wyatt et. al [5], *"medical informatics is the study and application of methods to improve the management of patient data, clinical knowledge, population data and other information relevant to patient care and community health"*. The core goal of the medical informatics field is to improve clinical care through the use of information technology. Various types of applications have been developed through the introduction of computers, which include health system management, clinical data management (patient records, laboratory, radiology, pharmacy systems), billing or patient finance systems etc [6, 7].

Many studies have been undertaken to evaluate the implementation of health information technology in health-care sector. This research is known as ‘evaluation study’ or ‘evaluation research’ in health informatics. Evaluation of the factors that influence user acceptance of technology is a vital process in many organizations including health-care because the success of technology largely depends on its acceptance by the users of the technology [8, 9]. Evaluation contributes towards understanding of successful adoption of the technology and also help to identify relevant tools and techniques to measure this success. The issue of user acceptance of health care technology is often the main focus of research within evaluation studies [10, 11]. Several significant models are widely used for studying user acceptance issues, such as the Technology Acceptance Model [12], IS Success Model [13], Task-technology Fit model [14] and many more. All these models have been widely used in the information systems research area and their use has been acknowledged and adopted within the health informatics research area as well [15, 16].

Information systems are part of social systems in which different people and environments are interacting with each other. In order to evaluate technology acceptance it is important to evaluate not only the user, but also the technology used, as well as the organization or management who introduced the technology. According to Hu [17], technology acceptance has three dimensions which are characteristics of the individual, characteristics of the technology and characteristics of the organizational context. Therefore, to better understand user acceptance of a particular health-care technology, evaluation needs to take into consideration how well the user, the technology and the organization are interacting with each other, or in other words, how they ‘fit’ with each other.

The importance of ‘fit’ has been recognized by Goodhue and Thompson who developed a model called the Task-technology Fit Model (TTF) [14]. According to this model information technology is more likely to have a positive impact on individual performance and is more likely to be used if there is a match between capabilities of the technology and the tasks that the user must perform [14]. According to Tsiknakis and Kouroubali [18], the limitation of the TTF model is that it focuses on the fit between the user and the technology and between the task and the technology, but does not focus on the interaction of user and the task which is important for the success of technology implementation.

This limitation has been addressed by Ammenwerth et. al [19] who proposed to add fit between the user, the task and the technology by developing a 'Fit between Individuals, Task and Technology' framework (FITT). However, this FITT model itself has limitations. In order to fully evaluate user acceptance issues the organization needs to be evaluated as well. That is the fit between the user, the technology and the organization needs to be evaluated together to understand user acceptance. Organization fit can be understood from a person-organization fit theory. Empirical evidence has shown that having high level of person-organization fit would resulted in a number of positive outcomes and this correlated with work attitudes such as job satisfaction [20, 21]. Technology is a means of achieving an organizations objectives and mission. Satisfied employees or users strive to achieve the organization's objectives and mission. Thus, having positive person-organization fit could highly influence user acceptance of technology introduced by the organization. This person-organization theory together with task-technology fit theory could better provide a means to understand the fit factor between user, technology and organization.

Kaplan and Shaw [22] highlight the following, *"Evaluation needs to address more than how well a system works. Evaluation also needs to address how well a system works with particular users in a particular setting and further why it works that way there, and what works itself means"*. This indicates three important aspects of evaluation which are the user, the technology as well as the organization. This clearly shows the need to evaluate technology along with the organization, as well as the people using it, i.e. the 'fit' along with factors that influence acceptance.

Furthermore, various studies have shown the importance of both management support and information security expectancy on influencing user acceptance [23–27]. These factors have been addressed in great detail in other disciplines. However, within the health care domain, these two factor need to receive equivalent attention as they play an important role in influencing user acceptance. Therefore, management support, together with information security, needs to be incorporated in evaluation models or frameworks that focus on user intention to use technology.

A number of previous studies have developed and proposed evaluation frameworks and models to support evaluation of health information technology. However, this research has highlighted limitations of the existing frameworks which could be improved upon. These include:

- The exclusion of the role of 'fit' within evaluation frameworks.
- The exclusion of management support and information security factors within existing evaluation frameworks as well as within existing technology adoption models. The importance of these factors have been shown in other disciplines and in particular, their influence on user acceptance.

The research in this thesis was in fact motivated by an investigation on acceptance of *Distiller Software* among postgraduate research students from the Breast Cancer Pathology Research group in Queen's Medical Centre (QMC), Nottingham. This research group purchased the software in 2007 and since then it has been gradually adopted by the research students in the group. However, some students are not keen to use the software. This motivated the researcher to investigate the reasons for differences in the acceptance of the same software.

The outcomes from evaluation studies should direct decision makers to take an appropriate course of action. Evaluation 'results' may indicate the status of system acceptance within the organization, i.e whether it is predominantly accepted or rejected by users. In order for management to take the appropriate action to remedy an unfavorable situation, it is important for the management to know which among the identified user acceptance factors is the most influential factor. Knowing the level of importance of each factor would help decision makers to handle the factors appropriately, rather than focusing its effort on less relevant factors. Existing evaluation studies try to find the answers for the question of why, what, who, when and how [1,28]. Although there are studies that discuss the critical success factors [9,29], a formal methodology to answer the question of 'which' should be explicitly introduced as an important evaluation question particularly in user acceptance studies. This thesis explores the applicability of multi-criteria decision analysis (MCDA) methods to provide the answer for the proposed question of 'which' in evaluation studies particularly user acceptance of health-care software.

1.2 Aims and Objectives

Although various studies have proposed evaluation frameworks, the frameworks overlook the importance of ‘fit’ between the user, the technology and the organization. Some frameworks propose the importance of fit between user and technology [19, 30] but do not address organization fit. Conversely a number of studies have shown the importance of organization fit with user or person [20, 21, 31] but do not address technology fit. This suggests a linkage between user, technology and organization fit as factors associated with user acceptance and highlights a gap in existing studies.

Although various studies have identified factors that would influence user acceptance [9, 29, 32, 33], these factors alone are unable to explain why the same system implemented in different settings result in different outcomes. This thesis aims to understand this through exploring the fit factor (as suggested by Ammenwerth et. al [19]) with the addition of organization fit and user and technology fit. Therefore, the first part of this thesis investigates the significance of fit between user, technology and organization with the constructs defined by the Unified Theory of Acceptance and Use of Technology (UTAUT) [34] and the DeLone McLean IS Success Model [35] in a single hypothesized model; with the inclusion of proposed management support construct and information security constructs.

The second part of this thesis is aimed to investigates the possibility of multi-criteria decision analysis (MCDA) methods as a means to answer the question of ‘which’ in user acceptance studies. Existing evaluations attempt to find answers for the why, what, who, when and how. A review of published literature shows that the inclusion of the ‘which’ question explicitly within evaluations has not been proposed.

In order to achieve the aims stated above, the following objectives were identified:

1. To investigate existing factors in user acceptance and to compare these factors with initial results obtained from investigating acceptance of *Distiller Software*.

2. To propose the role of perceived user-technology-organization fit as a determinant of factors defined by both the UTAUT and the IS Success Model.

3. To propose the inclusion of two new factors; management support and information security expectancy factor, within the proposed theoretical model.

4. To collect empirical data from medical students from various universities in the United Kingdom in order to validate the proposed theoretical model.

5. To examine the overall association between constructs proposed in the theoretical model from students' intention to use medically related software, specifically: perceived user-technology-organization fit as exogenous variables and performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating condition (FC), software quality (SWQ), information quality (IQ), service quality (SERQ), management support (MS), information security expectancy (ISE) as endogenous variables.

6. To collect empirical data for medically related software and research related software in order to perform the calculation of normalized weights for the factors and sub-factors using various MCDA approaches.

7. To examine the applicability of MCDA approaches to answer the question of 'which' explicitly within user acceptance studies.

The first part of this thesis discusses the first 5 objectives in **Chapter 3, 4, 5 and 6**. The last two objectives are discussed in second part of this thesis, in **Chapter 7**.

1.3 Research Questions

The aims and objectives stated above are focussed around various gaps in current knowledge, which are addressed in this thesis by formulating the following research questions:

1. What is the significant influence of perceived user-technology-organization fit (PUTOF) on performance expectancy, effort expectancy, facilitating condition and social influence factors in the context of a user intention to use technology?

2. What is the significant influence of perceived user-technology-organization fit (PUTOF) on system quality, information quality and service quality factors in the context of a user intention to use technology?

3. Does perceived user-technology-organization fit (PUTOF) influence management support and information security expectancy ?

4. Are management support and information security expectancy important in influencing a user intention to use technology?

5. Can the multi-criteria analysis method (MCDA) provide a means to answer the question of 'which' in user acceptance studies?

1.4 Overview of Research and Study Methodology

Empirical quantitative data (with a small section of qualitative data) were collected using Internet and drop-off surveys to examine the proposed underlying theoretical constructs. A self-administered questionnaire was considered to be the most appropriate tool and three different questionnaires were developed. The first questionnaire was used to collect empirical data to test the proposed hypothesized model. The second and third questionnaires were developed to collect data which were used to compute normalized weights between various decision elements, which in the context of this thesis, is between factor and sub-factors of user acceptance. Both questionnaires measured user acceptance factors.

The first questionnaire was developed using a five-point Likert type scales (ranging from 1=strongly disagree to 5=strongly agree). The second and third questionnaires also used five-point Likert type scales (ranging from 1= Equally Important to 5=Absolutely More Important). The Likert-Scales were adopted because they are easy and does not required much time to answer by the respondents [36]. The first questionnaire included a total of 43 measurement items measuring the underlying constructs in this thesis. These measurement items were adopted and adapted from previously validated scales although the wording of the measurement items were changed slightly to match the context of study in this thesis (medically related software).

In order to ensure that the questions in the questionnaire were clearly understood by the respondents, a pilot study was conducted prior to final survey. The target population in this thesis were medical students. The sample for the first and second questionnaires were medical students and for third questionnaire were research students. The first questionnaire was distributed using two approaches, Internet survey and drop-off approach and resulted in 113 respondents. For the second questionnaire, a total of 38 responses were obtained. The third questionnaire, also used the Internet survey approach and a total of 62 reply to the survey.

Descriptive analysis was performed using PASW software version 18. PASW was used to screen the data for missing data before conducting a partial least square (PLS) approach to SEM and also prior to calculating the normalized weight for factor and sub-factor using various MCDA approaches. To test the proposed hypotheses in this thesis, the PLS approach using WarpPLS version 3.0 (initially used version 2.0) was conducted. The analysis was conducted using a two-stage approach [37]. The objective of the first stage approach is to specify the causal relationships between the manifest variables (also known as observed variable) and the underlying theoretical constructs. The objective of the second stage is to test the proposed hypotheses which shows the relationships between these constructs. WarpPLS version 3.0 analyzed both stages simultaneously. The model fit was determined through several properties which include effect size, path coefficient, coefficient of determination and predictive relevance.

This research followed closely the recommendation by Urbach and Ahlemann [2] on process model for SEM-based research (the first part of research). Table 1.1 shows the proposed activities for PLS-SEM framework and the associated chapters address these activities in this thesis. Basically, there are six phases involved in research based on SEM. The first two phases of research are *problem definition* and *research design*. These are elaborated in chapter one and three. The theoretical foundation is discussed in chapter two. This is followed by the third phase which is *model construction and instrument development*, presented in chapter three. Chapter four discusses the fourth phase of the process model which is *data collection*. Phase five, *model validation* is addressed in chapter five. Chapter six and part of chapter eight complete the final phase of the process model for SEM based approach, which is an *interpretation phase*.

Phase	Activities and Results	Chapter
Problem Definition and Research design	**Research Question**	
	research question 1	1
	research question 2 etc.	
	Research Design	
	Development of theoretical model of user acceptance	3
	Transformation into structural equation model	3
	Empirical testing applying Internet-Survey and drop-off based research	3
Theoretical Foundation	**Literature Review**	2
	Evaluation and User Acceptance Study	
	User Acceptance and Adoption Theory	
	Task-technology Fit Model	
	Evaluation Framework and Theory Used	
	Evaluation Dimensions	
	Importance of Management Support	
	Importance of Information Security	
Model Construction and Instrument development	**Structural Model**	
	Deduction of determinants of user acceptance based on theories reviewed	3
	Combination of determinants and hypothesized relationship to casual model	
	Measurement Model	
	Development of new measurement items	
	Operationalization of variables in reflective and formative mode	
	Instrument: Questionnaire	
	Pre/pilot test: Pre-test with medical students	
Data Collection	**Target:** Medical Students from various university	4
	Responses: 113 respondents	
	Quality Assessment: Test for potential missing data, outliers etc	
Model Validation	**Validation of Measurement Model:** Assessment of indicator and construct reliability	5
	Validation of Structural Model :	
	Calculation of R-square	
	Evaluation of path coefficients	
Interpretation	**Discussion**	6
	Evaluation of hypotheses	6
	Drawing conclusions (answering research questions)	6
	Elaboration on limitation and future research opportunities	8

Table 1.1: Process model for PLS-SEM Approach

Part II of this thesis examines the applicability of multi-criteria decision analysis (MCDA) techniques to assign weights between user acceptance factors and was conducted using three very well-known and widely used methods which are classical analytic hierarchy process (AHP), Fuzzy AHP Chang's method and Fuzzy AHP α and λ method. The results support the inclusion of the question of 'which' within evaluation studies and provides additional support for MCDA techniques within health informatics research.

1.5 Organisation of the Thesis

This thesis is divided into two main parts. Part I which includes **Chapter 3, 4, 5 and 6** investigates the role of 'fit' as a factor in user acceptance studies. Part II includes **Chapter 7** examines the applicability of MCDA methods in user acceptance study.

Chapter 1 provides an overview of medical informatics as a scientific field which focuses on the role of health technology within the medical domain. This is followed by an overview of evaluation studies, user acceptance studies and the theory of technology adoption. Further, this thesis reviews relevant literature related to the importance of evaluation dimensions which include the user, the technology and the organization. This suggests the role of perceived fit between the user, the technology and the organization as a core determinant of those factors defined by the existing technology adoption model, which is one of the constructs that form the proposed theoretical model.

Further review suggests the importance of management support as well as information security provided by the technology as a determinant of user's intention to use technology. These two constructs further form the proposed theoretical model of user intention to use technology. The review of the literature also found the potential to enhance evaluation study questions (why, what, who, when and how). To examine the applicability of the addition of the question of 'which', multi-criteria decision analysis (MCDA) was used. Further review suggests this area of research has not been widely studied within evaluation studies particularly on user acceptance studies. Although Analytic Hierarchy Process (AHP) has been used in previous studies, the application of Fuzzy AHP was limited within healthcare domain.

Following on the literature in **Chapter 2**, **Chapter 3** discusses the proposed theoretical framework which integrates three well-known models. These are Task Technology Fit (TTF) model, the Unified Theory of Acceptance and Use of Technology (UTAUT) model and the DeLone McLean IS Success Model and hypothesizes as a single model with the addition of organization fit within the TTF model and management support and information security expectancy constructs within the UTAUT and the IS Success Model. It discusses the 11 hypotheses to be analyzed. H_{1a}, H_{1b}, H_{1c} and H_{1d} related to the influence of perceived user-technology-organization fit on constructs from the UTAUT model which include performance expectancy, effort expectancy, social influence and facilitating condition, respectively. H_{2a}, H_{2b}, H_{2c} represented the influence of perceived user-technology-organization fit on constructs from the IS Success Model which include software quality, information quality and service quality. Further, H_{3a} and H_{3b} represent the influence of user, technology and organization fit on two new constructs which are information security expectancy (ISE) and management support (MS). Finally, H_{3c} and H_{3d} represent the influence of ISE and MS on intention to use technology.

In **Chapter 4**, the methodology used to examine the proposed hypotheses outlines in Chapter 3 is presented. The methodology includes the research method used which justifies the use of quantitative method with small section of qualitative method. Further, this chapter discusses the measurement scale and measurement items used to measure the proposed constructs and the measurement instrument used to collect the data. Following this is the elaboration on the pilot test and final survey, justification the data analysis method used and software to analyze the data. Final section presents the ethical considerations related to the conduct of this research.

Chapter 5 presents the results of data analyzed using the techniques discussed in Chapter 4. This includes results on preliminary data analysis which include response rate and sample profile. The results on proposed hypotheses conducted using the two-stage approach are also reported in this chapter. WarpPLS version 3.0 software performed the analysis of both stages simultaneously and produced reports which are interpreted according to acceptable standard rules.

Chapter 6 interprets the results from investigating the 11 proposed hypotheses which aim to answer the four research questions outlined in Chapter 1. Theoretical and managerial implication of the study based on the results obtained are reported.

Chapter 7 is dedicated to the second part of the research which discusses the applicability of MCDA approaches to answer the question of 'which' within evaluation studies in user acceptance of health-care technology. It begins by discussing the three phase methodology which includes structuring a hierarchy model of user acceptance factors, measuring and collecting data and determining the normalised weights between decision elements. Further, it discusses the use of the quantitative method, the population sample choice, the measurement instruments used, the evaluation of this instrument through a pilot study and the final survey. Three widely used methods, Classical AHP, Fuzzy AHP

Chang's Method and Fuzzy AHP using α and λ are discussed and applied in assigning the ranking between factors and sub-factors for each type of software, Medical related software and Research related software. It reports the results for each approach using these methods. The results are interpreted to answer the final research questions identified on Chapter 1.

Finally **Chapter 8** discusses the contributions of the thesis. Limitations of the thesis and recommendations for future research are also discussed in this chapter. A list of publications and oral presentations derived from this work is reported at the end of the chapte

1.6 Contribution to Knowledge

Although the work in this thesis focuses on medical students and evaluating medical related software instead of focusing on real user and evaluating real medical software, the author believes the results obtained could contribute to the body of knowledge in evaluation studies focusing more generally on students' perspective of factors which influence intention to use or adopt medical software in future.

The proposed theoretical model contributes to existing theories on technology adoption by examining the linkage between perceived user-technology-organization fit with endogenous constructs defined by both UTAUT [34] and DeLone McLean IS Success Model [35]. The proposed model is empirically applied to medical students intention to use medically related software.

The importance of management support and information security were recognised in the first phase of the study as well as in the existing literature. The inclusion of these new variables as having consequences on user intention provides an additional contribution towards understanding factors influencing user acceptance of technology and towards evaluation studies in general. Importantly, the proposed perceived user-technology-organization fit construct in this research provides additional information and support to management of user acceptance issues particularly from the 'fit' perspective. Furthermore, through the knowledge gained from empirical data, a contribution can be made to the literature on the existing evaluation models or frameworks as well as existing technology adoption theories, to consider the inclusion of perceived ‘fit’ factor within the framework of user acceptance. The proposed model is examined within the health-care domain however the ‘generic’ features of the model should allow the proposed model to be applied and examined in other domains.

Within evaluation studies, the use of the Multi-criteria decision analysis (MCDA) method is limited and the applicability of this method in providing answers to the most influential user acceptance factors is proposed in this thesis. As far the author is aware there are no other documented works which suggest the inclusion of the ‘which’ question explicitly within evaluation studies on user acceptance. This question of ‘which’ is answered through MCDA methods, is also another contribution made by this thesis.

The research in this thesis led to several publications - four international conferences and one journal paper (submitted). A complete list of publications is reported in the final chapter.

Chapter 2

Literature Review on User Acceptance Studies

This chapter presents a reviews on the relevant literature related to the proposed theoretical model in this thesis and the inclusion of explicit assessment of 'which' in user acceptance studies. The review is organised into 17 section which includes search strategy (Section 2.1), overviews of health informatics (Section 2.2), evaluation research in health informatics (Section 2.3), user acceptance studies (Section 2.4) and existing theories of technology acceptance (Section 2.5). Section 2.6 presents a discussion on three important dimensions of evaluation namely the user, the technology and the organization fit. Within this section, the importance of fit between the person and the organization is illustrated in subsection 2.6.1. This is followed by the importance of user and technology and theory related to fit in Subsection 2.6.2 as background for discussing the construct of interest. While the importance of fit is recognised in Section 2.7, Section 2.8 discusses the proposed construct in this thesis. This is followed with a review of the need for management support and information security factors in influencing user acceptance, which are discussed in Section 2.9 and Section 2.10. Section 2.11 evaluates the existing evaluation frameworks from a fit perspective as well as theory used to develop the frameworks/model, to provide further background for discussing the chosen constructs for examine the proposed theoretical model. This is followed by Section 2.12 which discusses the observations and gaps in the body of knowledge. The second part of the research in this thesis presented in Section 2.13, discusses the questions addressed in evaluation studies to provide a foundation for the explicit inclusion of the question of 'which'. This is followed by Section 2.14 which discusses how the evaluation questions are addressed within existing user acceptance studies and how the questions of 'which' is addressed implicitly. Subsequently, Section 2.15 reviews the multi-criteria decision analysis technique as a means to assign weights to decision elements. Section 2.15.4 compares the differences between the Analytic Hierarchy Process (AHP) and Fuzzy AHP and is followed by Section 2.16 which discusses the application of these methods in various disciplines as a decision support tool. Section 2.17 provides second observations and gaps in the body of knowledge. Finally Section 2.18 summarises the chapter.

2.1 Search Strategy

In order to ensure that the work in this thesis is contributing to the body of knowledge, the collection of published articles in this area was assessed with the help of ProQuest and Web of Knowledge (Wok). Additional sources were retrieved from SAGE Journal online, Science Direct, Google Scholar and ACM digital library. The targeted search terms consisted of combination of keywords and phrases such as user acceptance, health care technology, health care software, success factors, fit factor, acceptance model,evaluation frameworks, health informatics, integrated models, evaluation, multi-criteria decision analysis technique, AHP, fuzzy AHP etc. Overall, around 500 related articles were retrieved from various sources, for both parts of the research. Nearly 285 articles were reviewed. The findings were synthesised, paraphrased and categorised under 15 broad themes as described in the rest of the sections in this chapter.

2.2 An Overview of Health / Medical Informatics

The Medical Informatics field has evolved over the past 70 years. According to Collen [38], the earliest published paper in medical informatics appeared in the 1950s and the number of papers published increased rapidly in the 1960s. This field of medical informatics was identified as a new specialty in the 1970s. According to Abdul-Kareem et. al [39], the very first symposium on Computer Applications in Medical Care was held in 1970. Since then, various medical informatics journals have been launched which include the International Journal of Medical Informatics (IJMI), the Journal of the American Medical Informatics Association (JAMIA), Artificial Intelligence in Medicine (AIM), Methods of Information in Medicine (MIM) and Journal of Biomedical Informatics (JBI) [40]. Some other related journals are Medical Informatics and Decision Making (BMC), the Journal of Health Informatics in Developing Countries (JHIDC), the Journal of Medical Internet Research (JMIR), the Health Informatics Journal and the Electronic Journal of Health Informatics.

Medical Informatics (MI) (also referred to as Health Informatics) is a discipline which focuses on realizing the potential use of computers in the health care sector. Various definitions have been given for the medical / health informatics term. For example, Bath [41] differentiate the term between medical and health as follows *"the use of the term 'medical' in medical informatics implies a specific clinical focus and the involvement of clinicians or doctors, while the word 'health' implies greater generality and the involvement of other health professions"*. Haux [42] defined this field as a cross-discipline area where research is primarily drawn from computer sciences, information sciences and medicine and is focused largely on the design and testing of medical information technology. According to Collen [38], the origin of the name 'medical informatics' was documented by Anderson at Kings College of Medicine (London) and this term is cover various terms which include medical computing, medical data processing, medical information processing, medical computer sciences, medical information sciences, medical information systems, health care information systems, computer hardware and software, computer and information technology, application of computers and data processing to the health services and basic concepts of computer sciences fundamental to medicine. Wyatt and Liu [5] defined medical informatics as *"a study and application of methods to improve the management* *of patient data, clinical knowledge, population data and other information relevant to patient care and community health"*. Bath [41] defined health informatics as *"the use of information and ICTs to improve the quality of care and health and well-being of patients, their families and carers, and the general public"*.

An important focus in this research area is to develop an understanding of the individual, group and organizational influences on IT development, adoption and use [43]. To achieve this goal, informatics researchers examine the design of IT applications to address the practicalities of health care delivery and focus on clinical users (e.g. doctors, nurses, physicians, pharmacists etc) [44]. The introduction of the computer has brought the development of various applications such as health systems management, clinical data management (patient records, laboratory, radiology and pharmacy systems), billing or patient finance systems, automated laboratory systems, imaging systems (ultrasound, nuclear medicine and magnetic resonance), process control and monitoring and information retrieval and many more [6, 7].

Lot of research has been undertaken to evaluate the implementation of health information technology which is known as 'evaluation study' in health informatics. A number of evaluation studies make use of theories from other disciplines including Information Systems. According to Lorenzi [45] researchers and students are encouraged to design their efforts around researched and accepted concepts from other disciplines in their informatics research. Nevertheless, a number of cross-disciplinary studies borrowing concepts from the Information Systems field have begun to enrich the informatics literature [15,16].

The scope of research in health informatics is huge and has given rise to sub-domains including clinical informatics, nursing informatics [46, 47], imaging informatics, consumer health informatics, public health informatics, dental informatics, clinical research informatics, translational research informatics, bio-informatics [48], veterinary informatics, pharmacy informatics and health care management informatics. Within health informatics, research in evaluating the implementation of health care technology and its acceptance among users is widely conducted. As noted by Talmon and Hasman [49], evaluation is an important part of any system development and implementation. The next section reviews existing evaluation research in health informatics.

2.3 Evaluation Research in Health Informatics

Over the past 30 years evaluation studies in health informatics have grown. Evaluation have become part of the planning, introduction and operation of technology in health care. According to Heathfield et.al [50], by undertaking evaluation it improve understanding of the role information technology in the health care and helps to deliver technology which offers both clinical and economic benefits. The term 'evaluate' is defined in the Cambridge Advanced Learner's Dictionary as *"to judge or calculate the quality, importance, amount or value of something"*. Thus, evaluation can be defined as the act of exploring property of a system and the result of which informs a decision concerning the system. Ammenwerth and Keizer [51] defined evaluation as a *"means to access the quality, value, effects and impacts of information technology and applications in the health care environment, to improve health information applications and to enable the emergence of an evidence-based health informatics profession and practice"*. Evaluation of system implementation occupies the top level of the tower science in health informatics formulated by Friedman and Wyatt [1], as shown in figure 2.1. Thus, in health informatics, evaluation of system implementation in health care is an important endeavor, evident through huge numbers of publications in various informatics journal [48, 52–54]

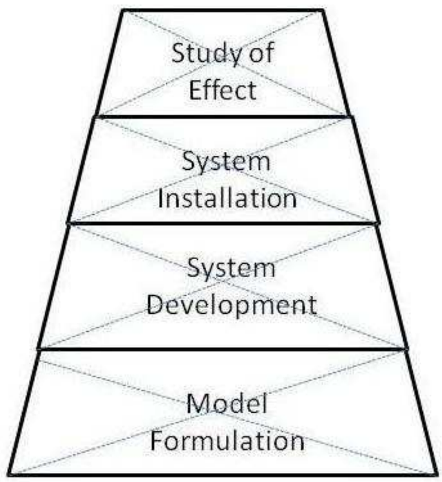


Figure 2.1: The Tower of Science in Medical Informatics formulated by Friedman and Wyatt [1]

There are two types of evaluation studies, namely formative and summative [1]. Formative evaluation aims to improve the technology by providing feedback to the developers or implementers [1]. Summative evaluation, on the other hand, aims to demonstrate the outcome of an information technology in health care [1]. Evaluation provides a means to the developers as well as implementers on how best the information technology could be used for a particular task in the health care delivery process. Furthermore, evaluation of health information technology provides evidence on whether the system meets the requirements and information processing needs of the clinical users and health care organization. There is growing published evidence on the impact of health informatics on health care which is shown by Ammenwerth and Keizer [51]. Chaudhry et. al [55] further provides evidence of evaluation studies in health informatics in the form of a narrative review, a systematic review or a formal meta-analysis on the impact of health information technology.

Various kinds of evaluation study dominate the research area, including the development of evaluation methodologies [7, 56, 57], impact of technology on the users [44, 48, 58], critical success factors of health care technology implementation [16, 29, 59] and many more. Among these, evaluation of user acceptance of health care technology is one of the main focuses of research within the domain of evaluation study [10, 11, 60] and is the focus of this thesis. The following section reviews user acceptance studies in health informatics.

2.4 User Acceptance Studies

Evaluation of the impact, effect and acceptance of health-care technology has greatly developed over recent years and has led to a huge number of methodological and practical publications [15, 23, 61]. Given the important role that health care technology has on the delivery of quality services, it is important that the acceptance of technology by health care professionals is evaluated to ensure it fulfills the needs and purpose of the implementation. Several examples of user acceptance studies and factors that influence acceptance are illustrated below.

Bossen [62] for example evaluated the computerised problem-oriented medical record (CPOMR) using a qualitative method for a period of 3 months. The users of the system were physicians and nurses. In this 3 months period, 66 patients were treated based on the information provided by the system. The results showed that using the system resulted in longer time in documenting clinical work, fragmentation of the patient situation as well as lack of overview. Although the system could be used to handle simple problems it did not work well to support complex clinical work or patients with complex problems.

Another study on user acceptance was conducted by Lemire et.al [63]. The author investigated the use of the Internet as a preferred source of information on personal health among 2923 users. The findings revealed that the five factors that influenced people's use of the Internet are perceived usefulness, importance given to written media in searches for health information, concern for personal health, importance given to the opinions of physicians and other health professionals and also the trust placed in the information available on the site itself.

Olala et. al [64] evaluated two groups of users of an emergency medical card (EMC) and continuity of care (CoC) report (medical professionals and medical students). The objective of the evaluation was to assess whether both reports would influence medical decision making process. The results demonstrate that both reports are useful in enhancing continuity of care at the point of care, therefore accepted by its users.

Wu et. al [9] investigated the acceptance of a mobile health care system (MHS) among health care professionals. The users of the information system included physicians, nurses, and medical technicians that worked for hospitals in Taiwan. The results indicated compatibility, perceived usefulness and perceived ease of use are positively associated with users' intention to use MHS. The proposed model explained 70% of the variances in the behavioral intention. The authors highlighted that the factors influencing user acceptance in their study were quite limited and suggests the including of other potential factors such as privacy and security issues, system and information quality etc.

Martens et. al [11] evaluated the acceptance of a computer reminder system (CRS) among general practice (GPs). The users of the systems are 53 GPs in 20 practices. The evaluation produced some interesting results. GPs were generally satisfied with the user-friendliness and the content of the different types of reminder but had mixed feelings towards the system. For example, they were positive about the guidelines provided by the system but not happy with the organizational context and the method used to implement the system. Also there existed barriers to cooperation and communication between the various parties and technical problems which requires multiple updates of the system and the operating system. The evaluation on the user acceptance shows different acceptance level among GPs although all use the same systems.

Royle et. al [65] evaluated clinical information system (CLINT) acceptance and satisfaction among 39 nurses in a medical teaching unit in a tertiary hospital in Canada. The results showed that peer mentorship, organizational support and collaboration were the most effective strategies for promoting system use. Nurses were willing to use the system when the system met their needs and was user-friendly.

Vest [66] evaluated factors that contributed towards adoption and implementation of health information exchange (HIE) in various hospitals. The study was based on a previously developed and tested framework which suggested three main factors influence an organizations's decision-making process. The factors were technological, organizational and environmental (TOE). Based on this framework, adoption and implementation of HIS was evaluated. The results indicated that factors associated with the adoption of HIS were not associated with implementation of HIS. The author concluded that factors other than just the technology are important for both adoption and implementation of technology.

Bansler and Havn [67] studied the pilot implementation of an electronic Pregnancy Record (ePR) in Denmark. Results showed three contributions toward the failure of implementation; (1) failure to define appropriate scope for the pilot implementation (2) failure to cope with unanticipated technical and practical problems (3) low commitment from test users and managers.

Petter and Fruhling [68] investigated success factors of an emergency response medical information system (ERMIS). This system is used to provide needed information for decision makers to determine actions to be taken in the event of a man-made or natural disaster. The participants of the study were 150 trained users across three Midwestern states in the USA. The IS Success Model developed by DeLone and McLean [35] was used as a framework for evaluation. The results showed that system quality, information quality and service quality all have a positive impact on both user satisfaction and intention to use the system.

The examples above clearly demonstrate that user acceptance studies take various forms. Some authors for example, developed a framework to investigate user acceptance issues [66, 69], some adopted an existing theory of technology acceptance to guide the evaluation study [68, 70, 71], some conducted general acceptance studies [8, 9, 11, 62–65] and other investigated reasons for low acceptance or failure of system implementation [67].

One of the aims of this thesis as listed in **Chapter 1** is to examine and understand the role of 'fit' by integrating several technology adoption models and to test the proposed model. In the next section, this thesis reviews some of the existing technology adoption theories which are widely used in various disciplines including health informatics.

2.5 Underlying Theories in Technology Adoption

2.5.1 Theory of Reasoned Action (TRA)

The TRA was developed by Fishbein and Ajzen [72] in 1975. The model suggests that an one's behavioural intention depends on the his or her attitude about the behaviour and subjective norms. If an individual intends to do a behaviour then it is likely that the person will do it. Attitude towards the behaviour means that an individual will judge whether or not to perform the intended behaviour. The subjective norms refer to an individual's perception of social pressures which influence him/her to perform or not to perform the behaviour. Attitude towards the behaviour is a function of beliefs that the behaviour leads to certain outcomes which depends on an individual's evaluation of these outcomes. Further, this model suggests intention as the immediate determinant of behaviour. The TRA model is shown in Figure 2.2.

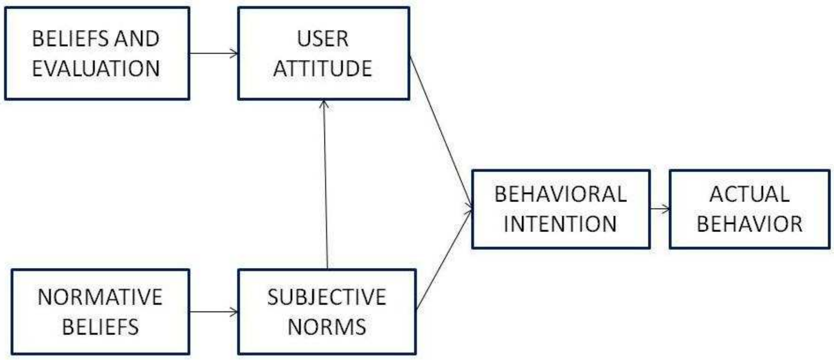


Figure 2.2: Theory of Reasoned Action

2.5.2 Theory of Planned Behavior (TPB)

Theory of Planned Behavior (TPB) was developed by Icek Ajzen in 1985 which is an expansion of the TRA model with the addition of perceived behavioural control [73]. This additional construct measures and accounts for the extent to which users have complete control over their behaviour. Perceived behavioural control indicates the extent to which an individual believes that he/she has control over personal or external factors which may facilitate or constrain them to perform a certain behaviour [74]. This construct is assumed to have direct effect on both behavioural intention and behaviour. This theory is widely used in predicting behavioural intention. For example Boyle et. al [75] used this theory to examine health care workers adherence to hand hygiene recommendations. The TRB model is shown in Figure 2.3. Some studies have utilised both of the above models for example to predict physicians' delivery of preventive services [76].

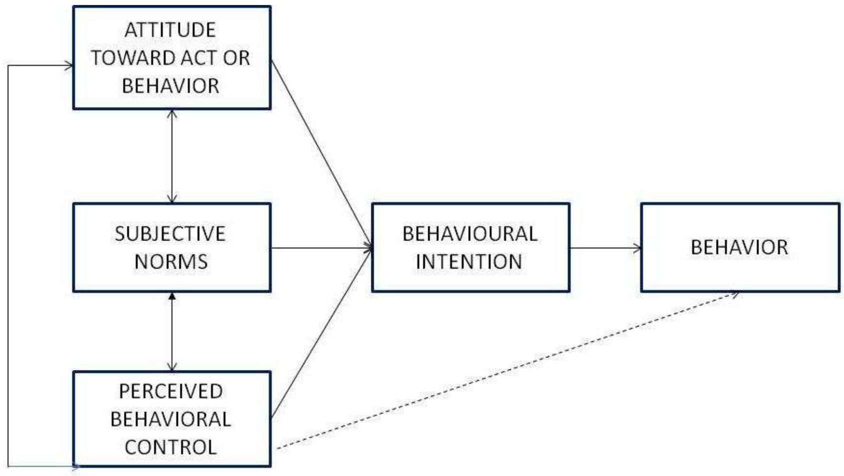


Figure 2.3: Theory of Planned Behavior

2.5.3 Technology Acceptance Model (TAM)

Fourteen years after the introduction of the TRA model in 1989, Davis [12] adapted it in the context of user acceptance of an information systems, resulting in the Technology Acceptance Model (TAM). Two major changes were suggested on the original TRA model. First, TAM only took the attitudes towards behaviour construct and left the subjective norms construct due to uncertainty in the theoretical status of subjective norms constructs. Second, the author identified two distinct beliefs which are perceived usefulness and perceived ease of use, to predict attitude of the user toward the use of a system. Davis [12] defined Perceived usefulness (PU) as *"the degree to which an individual believes that using a particular technology would enhance his or her job performance"*. Perceived ease of use (PEU) is defined as *"the degree to which an individual believes that using a particular system would be free of physical and mental effort"* [12]. Further, TAM suggests perceived ease of use will influence perceived usefulness for the reason that when all other things are considered equal, the easier the system is to use the more useful it can be. Venkatesh and Davis [77] criticised the model as lacking users' opinion on specific systems or technologies and called for vigorous validation and extension of this model under different environments in order to increase its explanatory power. Subsequently, the TAM has been used in various studies within health care domain [33, 78, 79]. Over the years, this model has received extensive empirical support through validation, application, and replication of its power to predict use of information systems within health care domain [78]. The TAM model is shown in Figure 2.4.

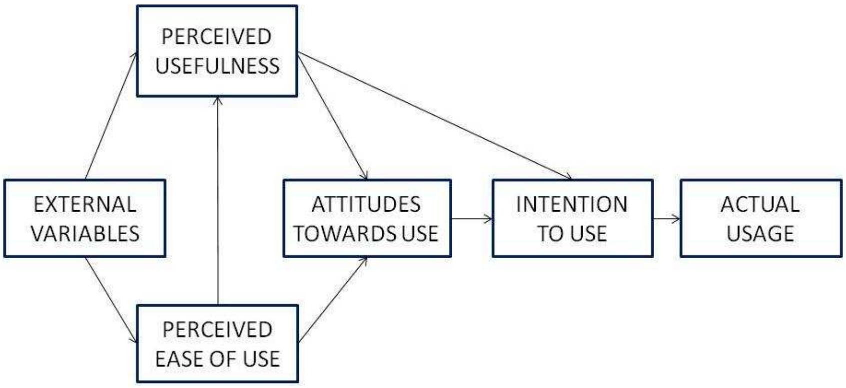


Figure 2.4: Technology Acceptance Model

2.5.4 Technology Acceptance Model 2

One of the important extensions to the original TAM model was proposed by Venkatesh in 2000 [80] who recognised the limitation of the TAM model in explaining the reasons for which a person would perceive a given system as being useful. Thus, Venkatesh [80] proposed additional variables as antecedents to the perceived usefulness variable in TAM. This new model, called the TAM 2 spans social influence (subjective norm, image and voluntariness) and the cognitive instrumental process (job relevance, output quality and result demonstrability). Venkatesh and Davis [77] conducted a field study with 156 knowledge workers who used four different systems, two of which were for voluntary use and the other two were mandatory. They concluded that the TAM 2 model performed well in both voluntary and mandatory environments with the exception that subjective norms had no effect in the voluntary setting as opposed to the mandatory setting. The TAM 2 model is shown in Figure 2.5.

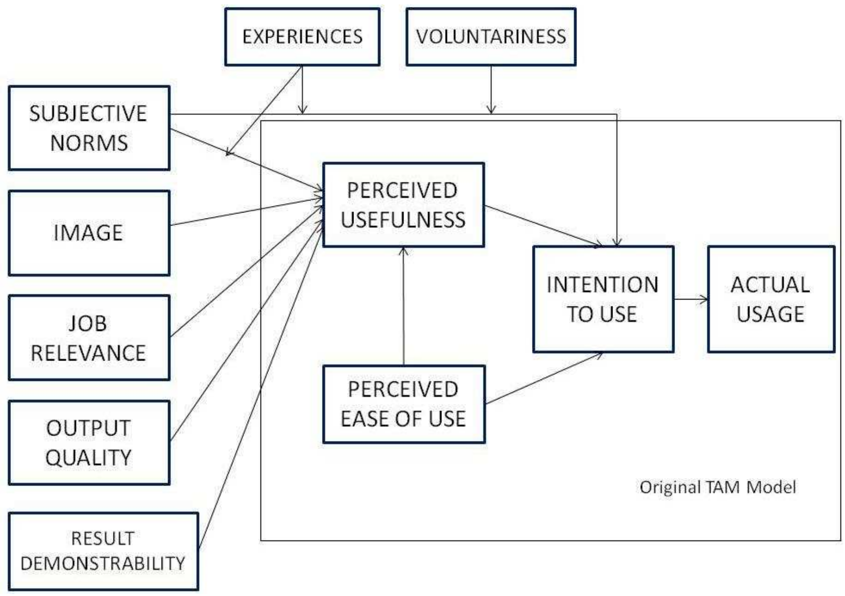


Figure 2.5: Technology Acceptance Model 2

2.5.5 Unified Theory of Acceptance and Use of Technology (UTAUT)

Three years after the introduction of TAM 2, Venkatesh et. al [34] expanded the model by introducing a model called the Unified Theory of Acceptance and Use of Technology (UTAUT) in 2003. The UTAUT model contains four core determinants of intention and usage which are, performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating condition (FC). UTAUT also introduces four moderators which are gender, age, experience and voluntariness of use. This model was built through synthesizing eight existing models of technology acceptance including TAM, Theory of Reasoned Action, Motivational Model, Theory of Planned Behavior (TPB), a combined TAM and TPB model, Model of PC Utilization, Innovation Diffusion Theory and Social Cognitive Theory. Constructs defined in the UTAUT model are similar to the constructs defined by the TAM model. Performance expectancy is similar to the perceived usefulness construct in the TAM model. The effort expectancy construct is similar to the perceived ease of use construct in the original TAM. The UTAUT model try to explain how differences in individual would influence technology use (moderator factor). The relationship between the constructs performance expectancy (PE), effort expectancy (EE) and intention to use can be moderated by age, gender and experience. The UTAUT model has been empirically validated among four businesses in various industries and cross validated using data from two organizations. The results show it to outperform eight other existing adoption models and is able to account for 70% of the variance in usage intentions towards technology adoption compared to other models which only explain 40% of the variance in acceptance [34]. The UTAUT model could provide a useful tool for managers who need to assess the chance of the successful introduction of new technology. Although UTAUT has not been as widely used as TAM, it is gradually being adopted to explore user acceptance or intention to use health related technology [15, 70].

The UTAUT model is as shown in figure 2.6.

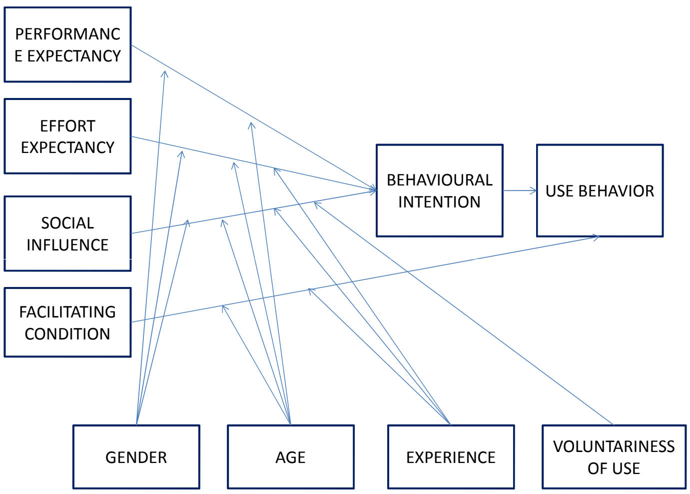


Figure 2.6: Unified Theory of Acceptance and Use of Technology

2.5.6 DeLone and McLean IS Success Model

Since its introduction in 1992 by Delone and McLean [35], the model has been widely used, evaluated, validated and extended in various studies. The original DeLone and McLean model provided a comprehensive framework for measuring the performance of information systems. The authors proposed six categories of IS success which include system quality, information quality, use, user satisfaction, individual impact and organizational impact. The amount of use can affect the degree of user satisfaction either positively or negatively. In 2003, the IS Success Model was updated with three changes. First, the inclusion of service quality factor to reflect the importance of service and support in success, for example in e-commerce systems. Second, the inclusion of intention to use factor to measure user attitude as an alternative measure of use. Finally, the merging of individual impacts and organizational impact into a more parsimonious net benefit construct [13]. The Delone and McLean model is shown in figure 2.7.

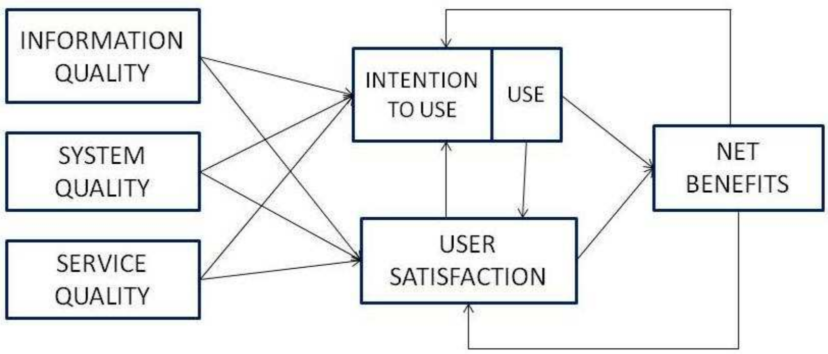


Figure 2.7: DeLone and McLean IS Success Model

The detailed description of the constructs is elaborated by Petter and Mclean [81] and will be further explained in **Chapter 3**. Bharati and Chaudhury [82] use this model to understand factors that impact decision-making satisfaction in web-based decision support systems. The findings reveal that both information quality and system quality influence decision-making satisfaction. However, information presentation does not have any influence on satisfaction. Table 2.1 shows the summary of the determinants of behavior which have been explained above.

The above section discussed several technology acceptance models which are widely adopted and used in various research disciplines including the health care domain. Each

Model	**Determinant(s)**
TRA	Perception + Attitudes towards the behavior + Subjective Norms
TRB	Attitude toward behavior + Subjective Norms + Perceived Behavioral Control
TAM	Perceived Usefulness + Perceived Ease of Use
TAM2	External Factors (Subjective Norms + Image + Job Relevance + Output Quality + Result Demonstrability) + Moderating Factor (Experience + Voluntariness) + Perceived Usefulness + Perceived Ease of Use
UTAUT	Performance Expectancy + Effort Expectancy + Social Influence + Facilitating Condition
IS Success Model	Information Quality + Service Quality + System Quality

Table 2.1: Determinants of Behaviour

of the above models proposed constructs that would influence user behaviour and subsequently influence their intention to use a technology or actual use of the technology. Having reviewed the defined constructs on user acceptance, the next section will review aspects of evaluation proposed in the literature to identify the key components that need to be presented in the user acceptance model.

2.6 Evaluation Dimensions and Fit Related Theory / Model

Information systems are embedded within social systems in which different people and environments interact with each other. In order to evaluate user acceptance issues, it is important that these three 'components' or dimensions are evaluated; *user, technology and organization*. According to Despont-Gros et. al [58], evaluation frameworks need to incorporate five common features, which include user characteristics, Clinical Information Systems (CIS), process characteristics, environment characteristics, and impact. The user characteristics define the attributes of the user, Clinical Information Systems are the technology itself, process characteristics are defined as the interaction between the user and the technology to perform given tasks. Further, environment characteristics defined by the framework are associated with organizational attributes and the impact is the result of the interaction between the user and the technology.

Additional support is provided by Hu [17] who explains that technology acceptance has three dimensions which are 'characteristics of the individual', 'characteristics of the technology' and 'characteristics of the organizational context'. Several other evaluation frameworks (described in section 2.11 below) also categorize factors that influence user acceptance of the technology under three broad dimensions which are user, organization and technology [15, 45, 83].

To better understand user acceptance, an evaluation needs to take into consideration how these three factors, user, technology and organization interact with each other. Success depends on how well these three 'components' 'fit' together to achieve the intended purpose of the health care technology. The concept of person-organization fit has been addressed in a number of studies related to user behavior. Further, the importance of 'fit' between the user and the task has been recognised by Goodhue [84] who developed a model called the Task-technology Fit (TTF). In this thesis, the researcher identifies three models / theories that discuss the 'fit' factor or an equivalent to 'fit' factor. The first is known as the Person-Organization Fit theory [31, 85]. The second is the Task-technology Fit model (TTF) [84] and the third is called the 'Design-Reality Gap Model' [86]. The following section reviews these three models.

2.6.1 Person-Organization Fit (P-O Fit) Theory

The implementation of a new technology or system needs to 'fit' with the organizational structure which it is meant to support. Implementation success or failure could be attributed to organizational issues. A number of studies has analyzed organizational issues and shown them to affect implementation [87, 88]. The organization itself is now considered as a key factor in the effective use of information technology, and as pointed by Lorenzi et. al [88] could also lead to system failure. Organizational aspects such as having no clear vision for change, ineffective reporting structures and roles and responsibilities that are not clearly defined or understood by everyone, are all could contributed towards low acceptance among user and consequently lead to failure of implementation.

One of the main reason for the failure is the difficulty that health care organizations face in choosing information systems which could support their organizational objectives and strategies [89]. According to Bush et. al [90], the alignment of systems is important because such systems can contribute to the success of the whole organization. Alignment is described as the extent to which implementation of information systems supports the organization's objectives and strategies [90].

The importance of the organization to the user and the users' role in the organization can be understood from a person-organization fit perspective. Person-organization fit is the degree of compatibility between people and the organization [31]. Empirical evidence has shown that a high level of person-organization fit is related to a number of positive outcomes and is correlated with work attitudes such as job satisfaction [20, 21]. According to Lauver and Brown [85], there are basically two types of fit; person-job fit (P-J) and person-organization (P-O) fit. P-J fit is defined as *"the match between the abilities of a person and the demands of the job or the needs of a person and what is perceived by the job"* [85]. While, P-O fit is defined as *"the compatibility between people and organizations that occurs when at least one entity provides what the other needs, they share similar fundamental characteristics or both"* [85]. P-O fit looks at how an individual matches an organization's values, goals and mission. The study examined how employees' perceived P-J and P-O fit relate to job attitudes and found that both types of fit have a unique impact on job satisfaction and intention to quit. Specifically the study showed that perceived P-O fit had a positive impact on contextual performance.

Further, Chatman [21] defined person-organization fit as *"the congruence between the norms and the values of organizations and the values of people"*. Person-organization fit is important as it enhances ones ability to predict the extent to which he or she will adhere to organizational norms. Verquer et.al [91] conducted a meta-analysis review of studies related to person-organization fit with job satisfaction, organizational commitment and intent to turnover. The review looked at four moderators which included the type of fit measure, method of calculating fit, dimensions of fit, and use of an established measure of person-organization fit. The reviews concluded that the person-organization fit appears to be promising as an important determinant of employee attitude with still some other issues yet to be investigated.

Further support on the importance of person-organization fit was provided by a study by Bertz and Judge [20]. The study employed and extended 'the theory of work adjustment (TW)' by examining person-environment fit in the organizational setting. As indicated by the author, fit has long-term benefits and can lead to a higher level of job satisfaction as well as extrinsic career success. Organizations need to be aware of the importance of 'fit' because, as stated by Bertz and Judge, *"those who fit would succeed and contribute to the success of the organizational while those who are not well matched to organizational conditions are less likely to be effective performers in those organizations"* [20]. Further evidence presented by Hong and Kim [92] shows that ERP implementation success significantly depends on the organizational fit of ERP and implementation strategies.

The presence of person-organization 'fit' leads to better users' performance as well as helping the organization to achieve its objectives as well as goal and mission. Having positive person-organization 'fit' could help the implementation of a new system if users' perceive that the new system would help the organization to achieve its values. Therefore, fit between user and organization is important to help the organization to achieve its strategic objective. The introduction of a new system is meant to support an organization's intended objectives and this new system would be successful when users accept the system or have intention to use the system.

Thus, to understand user acceptance issues, it is important to know how users 'fit' with the organization. To better understand user acceptance, three dimensions needs to be explored as discussed in section 2.6. The success of the system implementation also depends on how well the intended system supports the task the user needs to perform to achieve organizational objectives. The following section discusses models related to task-technology fit.

2.6.2 Task-Technology Fit (TTF) Model

One area that constantly receives attention from information systems researchers when considering technology acceptance issues is 'fit' between the user and the technology which is based on the Task-Technology Fit model (TTF) [14, 30]. Task-Technology fit measure the degree to which the technology helps a user to perform a given task. The TTF model is as shown in Figure 2.8.

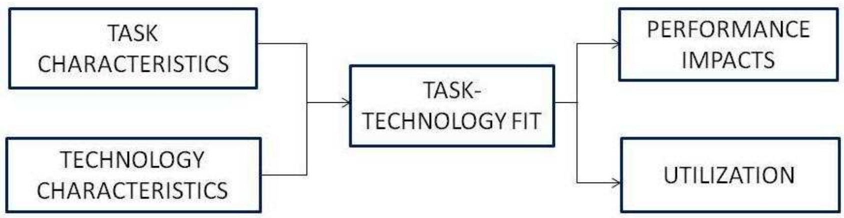


Figure 2.8: Task-Technology Fit Model

TTF holds that information technology is more likely to have a positive impact on individual performance and is more likely to be used if the capabilities of the technology match the tasks that the user must perform [30]. As Goodhue et. al [84] write, *"performance impacts are dependent upon the 'fit' between three constructs: technology characteristics, task requirements and individuals' abilities"*. This model focuses on the degree to which a systems' technology characteristics match users' task needs, hence the name 'task-technology' model. Technology characteristics in this model refer to the technology which is used by the user to perform intended tasks [14]. Task characteristics on the other hand refer to "the action carried out by individuals in turning inputs into outputs" [14]. According to this model, the higher the fit between tasks and technology, the better the performance.

Bleich and Slack [53] demonstrate the importance of 'fit' between the user and the technology and state the following, *"the key enthusiastic acceptance of electronic medical records is computing that is easy to use and helpful to doctors and other clinicians in the* *care of their patients"*. These two factors, ease of use and helpfulness, are viewed as interactions between the user and the technology, i.e, fit between user and technology. Ease of use is perceived by the user when the user believes that he or she has the skills to use the technology. The presence of 'fit' will determine the presence of the 'ease of use' construct. The same applies to the 'helpful' construct. This view is supported by Goodhue et. al [84] who state that one person performing the task may have a different view of the technology than another person performing the same task, indicates that the fit will differ for different users. Consequently, different individuals may have different responses to the same system. This is why the same system is sometimes accepted by one user and rejected by another [18].

Further, it has been suggested in a number of studies that this model can be extended with other related concepts in order to provide a comprehensive explanation of the relationship between task, technology, task-technology as well as utilization of the technology [93, 94]. Study by Dishaw and Strong [95] for example shows that the TTF model was extended with a self-efficacy constructs to provide further explanation on the relationships between defined constructs. Some studies also suggested that the TTF model lacks in integrating the effect of a user's behaviour and therefore proposed to integrate the TTF with other technology adoption models [93, 94, 96].

As noted by Tsiknakis and Kouroubali [18], the limitation of the TTF model is that it focuses on the fit between the user and the technology and between the task and the technology and does not look into the interaction between the user and the task which is important for the success of the technology's implementation. This limitation has been addressed by Ammenwerth et. al [19] by proposing a "Fit between Individuals, Task and Technology" framework (FITT). This framework suggests the idea that technology adoption depends on the fit between attributes of users, attributes of the technology and attributes of the clinical tasks and processes. However, this framework is limited by its failure to include organizational fit explicitly. The organization fit has been incorporated as part of individual aspects and task aspects. As illustrated in Section 2.6 and Section 2.6.1, to fully evaluate user acceptance the fit between the user, the technology and the organization needs to be evaluated together.

2.6.3 Design-Reality Gap Model

Another model which introduces similar concepts to the TTF Model is the 'design-reality gap' model, commonly known as ITPOSMO which stands for Information, Technology, Process, Objectives and values, Staffing and skills, Management systems and structures and finally Other resources [86]. ITPOSMO suggests that success or failure of new health information systems depends on the existence of the gap between reality and design. The larger the gap between the design of the system and the reality of the operational system, the higher the chance of implementation failure. This concept is very similar to the concept proposed by the TTF model. However, the TTF discusses the issue of acceptance from a 'fit' perspective, while the ITPOSMO discuss it from a 'gap' perspective. Compared to the TTF, this model presents more dimensions of evaluation. It introduces seven evaluation dimensions which are information (data stores, data flow), technology (both hardware and software), process (the activities of user and others), objectives and values, staffing and skills, management systems and structures and other resources (particularly time and money).

The main observation made on both the Task-technology fit and Design-Reality Gap models is the **exclusion of organization fit**. Both models ignore the 'organizational' attributes. The importance of person or user with organization fit can be understood from person-organization fit relationships described in Section 2.6.1. In sum, many studies on person-organization look at how the relationship between the person i.e user and the organization itself affect their job performance and subsequently the job satisfaction. Various studies on technology acceptance measure job satisfaction as an indication of actual usage of the system or technology. Thus, this thesis proposes to incorporate the person-organization fit with the fit between the user and the technology defined by the TTF model (discussed on Section 2.6.2) to better understand user acceptance issues. The following section reviews related studies which have illustrated the 'fit' between user, technology and organization.

2.7 Fit Between User, Technology and Organization

This section briefly reviews existing studies on user acceptance which demonstrate the ‘fit’ between the user, the technology and the organization. The higher the ‘fit’ between user, technology and organization, the higher will be its influence on user acceptance factors. A user with general IT skills is not a sufficient requirement for the use or acceptance of a new system but rather their skills must match the requirements of the system itself. This demonstrates the need of ‘fit’ between user and technology. Additionally, if the user does not have the necessary skills, the management must provide appropriate training to ensure the technology is accepted and used effectively. If the ‘fit’ between user and technology is low, it will eventually result in the rejection of the system [18]. As stated by Bush [90], *“the selection of new information systems needs to support both the objectives and the strategies of the organization”*. Thus, any new system needs to be aligned with the current settings and social organization it is meant to support. This indicates the need of ‘fit’ between technology and organization.

Kaplan and Shaw’s [22] recommendations for IT evaluation highlight the following, *“Evaluation needs to address more than how well a system works. Evaluation needs to address how well a system works with particular users in a particular setting and further why it works that way, and what works itself means”*. This clearly shows the need to evaluate technology along with the organization, as well as the people using it, i.e. the ‘fit’ along with factors that influence acceptance. Another example which demonstrates the ‘fit’ between user, technology and organization is work by Bossen [62]. The author conducted a three month case study on the daily use of a computerised problem-oriented medical records (CPOMR) at a university hospital in Denmark. The findings showed that the use of the system led to longer time spent in documenting clinical work because of the fragmentation of a patient situation into separate problems. Further, the system could not provide an overview of patient records when needed. Although the system was useful for patients with few or simple problems, it was not useful for patients who were admitted for longer periods of time. It was concluded that the prototype did not support daily clinical practice [62]. This example clearly shows the absence of good ‘fit’ between user and technology can lead to implementation failure. This example shows how crucial is the presence of ‘fit’ between user and technology. Within health-care context for example low 'fit' between user and technology could at least resulted in delaying patient care and at most could contribute to patient death.

As described in section 2.6.2, the TTF model needs to be extended to provide better explanation of user acceptance issues by incorporating person-organization elements. This is supported by the work of Thompson *et. al* [97] who defined a construct called 'job fit' which measures the extent to which a person believes that by using a personal computer can enhance his or her job performance. The results indicate that technology is more likely to be adopted when it fits with an individual's job responsibilities, hence improving job productivity. Improvement in job performance perceived by the user is similar to the construct defined in the UTAUT model called 'performance expectancy'. Thus, the work by Thompson et. al [97] provides further empirical support for the need and importance of this external factor. In the context of this thesis, it would be the 'fit' factor which would have an influence on constructs defined by the existing technology adoption models. Additional support is given by Goodhue [98] who suggested that an important predictor of use is the link between job task and the capabilities of the information system to support the task. The next section discusses the proposed constructs in this thesis.

2.8 Perceived User, Technology and Organization Fit

As the previous discussion showed user acceptance could be better explained from a 'fit' perspective. In other words, most of the identified factors on user acceptance [11, 79, 99] could be described as a result of 'fit' between the user, the technology and the organization. Identifying the factors alone, the researcher believes, is insufficient to fully explain differences in acceptance of the same system [19, 51]. For example, a number of studies have identified the construct 'ease of use' as an important user acceptance factor [15, 18]. However, measuring 'ease of use' alone cannot explain why the same system is accepted in one setting and rejected in another setting. This construct, 'ease of use', is dependent on the 'fit' factor. When a user accepts the system, this may be due to them having the necessary skills and knowledge to use the system i.e. the user perceives there to be a 'fit' between them and the technology. If the user is aware of the skills or knowledge needed for the task and technology and also believes that they possess these skills or knowledge, they will perceive there to be a better ‘fit’. This is called ‘perceived fit’. Thus, the construct ‘ease of use’ identified by previous studies [15, 18], for example, could be viewed as a result of perceived ‘fit’ between the user and the technology. Further, a user who rejects the system may simply not have the skills and knowledge needed to use the system i.e. an absence of ‘fit’ between the user and the technology. Two different users with different skills may perceive the same system differently and that is because of differences in how they perceive the ‘fit’ [84]. Additional support is provided by Larsen et. al [100] who proposed perceived task-technology fit as a determinant of utilization and perceived usefulness construct.

Table 2.2 provides some examples of user acceptance factors which could be classified as a result of good ‘fit’ between the user, the technology and the organization. Table 2.3 demonstrate examples of user acceptance factors which could be classified as poor ‘fit between these three entities. For example several authors [23, 53, 101] mentioned that a system was accepted by the user because the system had benefited the user. This factor ‘benefit to user’ is a result of good fit between the user and the technology. This thesis proposes that if, and only if, there exists a ‘fit’ between the user and the technology, the system would be viewed as a benefit to the user and will subsequently influence their intention to use or adopt the new technology.

Factor(s)	Reference(s)
System benefited user and/or patient	[23, 53, 101]
Time spend is less on clinical related work	[102]
User have computer experience/ knowledge/ skills	[19, 102, 103]
Organization provides training and accommodate team requirement	[71, 88, 99, 104]
System provides sufficient speed to accomplish jobs	[11, 103]
Systems is ease to use and useful	[93–95, 105]
User gets support from top management/managerial commitment	[18, 83, 101]
Organization promotes team spirit/ team-work	[101, 104, 106]
Management provides supportive working environment and in-house technical support	[23]
Management provides right technology which meets the requirements of the job	[103]
Technology is designed for all level of users	[105]
Good help desk support by vendor/technical support/administrative support	[11, 71]

Table 2.2: Examples of Good ‘fit’ between User, Technology and Organization

The ‘fit’ between the dimensions or attributes of the user, the technology and the organization is more important than the attribute itself and could help to better understand user acceptance issues. To understand user acceptance issues, it is important to understand how the user, technology and organization interact with each other to achieve the intended purpose of the technology. This interaction is known as ‘fit’. The limitation of

Factor(s)	Reference(s)
System negatively impacted staffs' work flow	[23, 53, 101]
System's problem such as content, computer generated forms hardware and interface	[102]
System did not meet user's practice requirement	[103]
Poorly designed system which increases workload/paperwork	[62, 99, 107]
Information systems which is not ready to be used and does not support management	[107, 108]
Lack of standardised terminologies which clinicians used to work with	[18]
User who has less/insufficient experience with technology limited skills to use the systems	[62, 109]
Technology that does not meet clinical needs or match with work flow	[106]
Lack of internal IT support	[18, 110]
Lack of coordination at operational level	[107]
Insufficient training	[102]
Organization does not provides training or educational program to the user	[110]
Insufficient number of computer, printer problems, system downtime, system breakdown	[102]
Mismatch or misalignment between facilities and social organization it meant to support	[87]
Interaction problem between new system and existing system - complex, time consuming, susceptible for error	[86, 111]
Prototype lacking in functionality or usability	[62]
Technical problems/multiple updates to the information systems/ operating system	[11, 88, 105]

Table 2.3: Examples of Poor 'fit' between User, Technology and Organization

person-organization fit is the lack of inclusion of the technology factor (discussed in section 2.6.1). On the other hand, the limitation of the task-technology fit model is the lack of inclusion of an organization element (discussed in section 2.6.2). Thus, this thesis proposes to integrate the strength of both models and proposes a construct called **perceived fit between user, technology and organization** to be examined as a determinant of user acceptance of technology.

Further, the main observation made from reviewing user acceptance factors together with existing technology adoption models is the absence of two important constructs which could have significant influence on user acceptance of health care technology. These are Management Support and Information Security Expectancy. Although a number of studies have shown the importance of management support and information security expectancy, as discussed in Section 2.9 and Section 2.10 as below, this thesis argues that these two factors need to be integrated together with existing technology acceptance related model to fully 'capture' user acceptance factors.

2.9 Management Support

The role and importance of management support has been addressed in a number of studies concerning information systems implementation [23–25]. As stated by Ragu-Nanthan et. al [24], *“top management support for the system emerges as a critical component in enhancing the role and functionality of the system in supporting organization strategy”*. Given the importance of information systems and their role as an organizational resource, management support is crucial in influencing user acceptance of technology. Management Support or top management support is defined as *“the degree to which top management understands the importance of the information system functions and the extent to which it is involved in information system activities”* [24].

A study by Teo and Ang [112] found that the majority of organizations that had major problems in the planning, development, or usage of information systems attributed the problems to ‘failing to get top management support’. Further, Ragu-Nathan et. al [24] developed a two-tier framework to show the relationship between top management support, the information systems function and information systems performance. The results provide support for both direct and indirect relationships between top management support and information systems performance.

A study by Igbaria et. al [113] provides further support on the effect of organizational factors (including management support) on factors defined by the technology acceptance model, namely ease of use and perceived usefulness. Further to this work, Igbaria et. al [113] conducted a study on personal computing factors in small firms and found that management support has a positive direct effect on perceived usefulness and perceived ease of use. These studies by Igbaria and other study by the same author [114] offer evidence of the impact of top management support on end-user computing satisfaction including system usage and perceived effectiveness.

Within health care sector, number of studies examines the role of management support as an important user acceptance factor. For example, study by Randell and Dowding [23] shows that providing a supporting environment as part of management/organization support could have positive impact on nurses’ use of clinical support system. Lammintakanen et.al [107] investigated the use of electronic information systems in nursing management. The study shows that to implement information systems, nurse manager faces several challenges which include manager, employees, atmosphere and changing the working process. One of the responsibilities of the nurse manager was to identify and clarify the meaning of information systems to the work process and to justify the use of the system in the work process. Further, it was suggested that learning and using the information system was supposed to take place in a positive and encouraging atmosphere and it was the duty of the nurse manager to promote such an atmosphere. This study clearly shows the importance of support from the management in influencing employees use of a new system.

Lu et. al [115] reviewed the literature on issues related to adoption of personal digital assistance (PDAs) in health care and barriers to PDA adoption. The reviews shows that one of the barriers for the adoption of PDAs among health care practitioners was lack of institutional support. This work provides further support for the inclusion of support from management or organization as a user acceptance factor. Davis [116] proposed that future research should consider the role of additional variables such as familiarity or experiences, top management support, user involvement and task characteristics. The construct 'familiarity or experience with the technology' has been incorporated in the UTAUT model by Venkatesh et. al [34]. The construct 'task characteristics' has been considered by Goodhue [30] who proposed a model called Task-technology fit. However, apart from the 'user involvement' construct, the researcher has found no evidence of incorporating explicitly the construct 'management support' with existing related technology acceptance model to explain user behaviour towards acceptance of technology.

Reviewing user acceptance studies (described in Section 2.4) above as well as various technology adoption models (described in Section 2.5), suggests that this factor needs to be further analyzed and incorporated as an important factor in user acceptance. Empirical studies which involve management support such the one cited above are sparse. Prior studies have shown and identified top management support as a parameter in the success of information systems, but the nature of its impact on user acceptance needs to be analyzed in further detail in order to enhance understanding on the issue surrounding system implementation. This thesis will examine the influence of 'management support' in user intention to use technology. As a conceptual model linking perceived 'fit' factor to management support is not available, this thesis introduces the management support construct and suggests that it be incorporated together with the other factors identified in this thesis. There is thus a lack of theoretical model which portrays the relationship between all established user acceptance variables with the management support variable.

2.10 Information Security

Information security has become one of the most important concerns and challenges facing organizations and users of the health care technologies ever since health care information systems were first implemented [26, 27, 117–121]. The volume and sensitivity of patient information collected and stored in the database means that security issues must be taken extremely seriously. The wide availability of patient health information in the form of electronic form raises an important concerns on the privacy of patient as well as security of data. Management must ensure that when introducing computerised health care systems, it can guarantee protection of the confidentiality and integrity of patient information.

The perception of health care practitioners of the security of information provided by the technology or software has been shown to be important in the acceptance of the health care technology or software. A study by Ayatollahi et. al [119] for example showed that emergency departments had staff who were not confident in the confidentiality of the information in the systems they used, indicating low acceptance of the system.

According to Cavalli et. al [122], many information systems have not been designed to be secured. If the system is perceived by the user to lack information security, the clinicians will be reluctant to use the system. Gritzalis and Lambrinoudakis [123] proposed a security architecture which is mainly designed to provide authentication and authorization services in web-based distributed systems. Only when the users of the technology perceive that a particular technology provides features which prevent unauthorised access to the clinical related database, will they accept it. In other words, when users perceive that information related to clinical purposes are protected they will be more likely to accept the system.

Goodhue and Straub [124] proposed a theoretical model of security concern which suggests task characteristics, information system environment and individual characteristics will have an effect on perception of the satisfactoriness of security measures. The empirical tests of the proposed hypotheses found only partial and weak support, however the theory itself may still prove to be viable if a validated instrument is developed.

Lu et. al [115] investigated the factors associated with the adoption of personal digital assistance (PDAs) among health-care practitioners and found that one important barrier for adoption is security such as in data encryption.

The importance of information security has been addressed in number of studies as shown above. However, the 'information security' construct has not been incorporated within technology adoption models or frameworks related to user acceptance. Thus, in this thesis, the information security factor is included in the proposed model as a predictor for user intention to use health care technology. Since this thesis measures users' intention, this thesis proposes a construct called information security 'expectancy'. This information security expectancy construct will be further elaborated in **Chapter 3**.

Previous work on user acceptance is discussed in Section 2.8 and suggests that the identified factors on user acceptance in the literature could be a result of either 'good fit' or 'poor fit' between user, technology and organization. As illustrated in Section 2.4, one form of evaluation is developing an evaluation framework or model. The following section reviews an existing evaluation framework to identify constructs defined by the framework/model, the use of any technology adoption model and to identify if 'fit' has been incorporated within these evaluation frameworks.

2.11 Evaluation Frameworks

A lot of research has been carried out to develop and propose frameworks or models to support evaluation studies of health information systems. As stated by Heathfield et. al [125], *"development of an evaluation framework for health care information systems is an important step towards realizing the benefits of such systems"*. The framework helps to identify success factors and to understand the relationship between these success factors. Most of the frameworks were developed based on influences from other disciplines. Chiasson et. al [43] stated in his article *"as health-care organizations increasingly adopt IT across a broad range of functions and process, the challenges with developing, implementing and using health care will continue to grow"*. The author further suggests that borrowing theories and methods which have been developed in other disciplines could provides benefit for advancing research.

The term framework is defined in Cambridge Advanced Learner's Dictionary as:

1. *'a supporting structure around which something can be built'*

2. *'a system of rules, ideas or beliefs that is used to plan or decide something'*

Despont-Gros et. al [58] defined evaluation framework as *"a decisional space defined by the characteristics of the evaluation context that helps in the selection of the appropriate approach"*. In fact, many authors have expressed the necessity for such a framework as shown in Table 2.4:

Author(s)	Importance/ Need for an Evaluation Framework
[126]	"...frameworks help in making evaluation of new system to be deployed or newly deployed to access organizations readiness, make the necessary mid-course correction i.e. to reduce risk and be prepared to deal with the currently identified unintended consequences of cope should they occur."
[19]	"...a framework helps analyzing process of IT adoption during an IT implementation"
[125]	"Evaluation project led us to believe that the development of an evaluation framework for health care IS is an important step towards realizing the benefits of such systems. Without such a framework, it is not possible to identify those factors which are the most important determinants of success, understand the relationship between these factors or make predictions based upon the assessment of these factors."
[127]	"Since CIS is a complex system which supports various functionalities and tasks for various user profiles, we found it necessary to design an evaluation instruments, which addressed these different dimensions across all main components of the CIS."
[58]	"...a general evaluation framework would be a good tool for descriptions and explanation of findings"

Table 2.4: Importance of Evaluation Frameworks

Table 2.5 lists number of existing evaluation frameworks. It presents the name of the framework or model and more crucially whether fit is included within the proposed

Name of the framework	Technology Adoption Model	Emphasize/ Include Fit	Ref.(s)
Design-reality Gap model	No	No	[86]
ICT and OTs	UTAUT and TAM	No	[15]
CHEATS: a generic ICT evaluation framework	No	No	[128]
TEAM: Total Evaluation and Acceptance Methodology	System and Model Theory	No	[129]
Comprehensive Health Technology Assessment	No	No	[130]
A model based on human interaction models	IS Success Model, TAM and TTF Model	Yes	[58]
HOT-fit	IS Success Model and IT-Organization Fit	Yes Yes	[16]
FIIT — Fit between Individual, technology and Task	IS Success Model, TAM, IT adoption model	Yes	[19]
Risk Assessment Framework	No	No	[131]
Health technology Assessment (HTA)	No	No	[7]
4Cs	No	No	[132]

Table 2.5: Use of Technology Adoption Model and Inclusion of 'Fit' in Existing Evaluation Frameworks

framework. It is apparent that very few existing frameworks have incorporated a 'fit' factor. Those frameworks or model which has included the 'fit' factors [16, 19, 58] neither incorporate organization fit explicitly (together with user and technology) nor examine the fit between user,technology and organization as a predictor of user acceptance factor, which is addressed in this thesis. Also, compared to the TAM model [78], the use of UTAUT and the IS Success Model within the health care domain is limited. Further, to the best of the researcher's knowledge, the constructs 'management support' and 'information security expectancy' are not addressed in any existing evaluation frameworks above. Although studies suggest the construct perceived task-technology as a determinant of those constructs defined by existing technology acceptance models [95, 96, 100], no work suggests perceived 'fit' between the user, the technology and the organization construct, which is proposed in this thesis.

This thesis proposes the integration of the UTAUT model with the DeLone IS Success Model to answer the proposed research questions outlined in **Chapter 1**. Although one might argue that the system quality construct defined by the IS Success Model has some of the attributes of ease of use which is similar to the effort expectancy construct as defined by the UTAUT model, and also usefulness of system which is similar to the performance expectancy construct defined by the UTAUT model [35], this thesis, adopts these constructs from a different perspective. As described in section 2.6, to evaluate system implementation, three components (user, technology and organization) need to be evaluated together. The constructs proposed in the theoretical model, (described in **Chapter 3**), are categorised within these three components. The constructs from the UTAUT model (performance expectancy, effort expectancy and social influence) are defined as attributes belonging to the user. Further, attributes such as system quality, information quality and service quality defined by the IS Success Model are more closely related to the technology or system characteristics itself and these factors are classified within the technology component. The construct facilitating condition defined by the UTAUT model together with a newly proposed construct (management support) are categorised within the organization component. By categorizing the constructs from the UTAUT and the IS Success model together with the newly defined constructs from this thesis within these three important evaluation dimensions, this thesis will cover the important aspects of user acceptance. Furthermore, a study by Seddon and Kiew [133], examined constructs defined by the DeLone McLean IS Success Model with a perceived usefulness construct which is one of the constructs from the TAM model. This provides further support to integrate the UTAUT model with the IS Success Model. Both UTAUT and the IS Success Model define constructs which measure user intention to use technology, however they do not consider user perceptions on how well the technology fits them.

2.12 Gaps in the Knowledge (First Part of Research)

After reviewing evaluation research (Section 2.3), user acceptance studies (Section 2.4), related theories in technology adoption (Section 2.5), evaluation dimensions (Section 2.6, importance of perceived user, organization and fit (Section 2.8), importance of management support (Section 2.9), importance of information security (Section 2.10) and existing evaluation frameworks (Section 2.11) for the first part of research the following observations are made:

i The TTF model focuses and discusses the fit between user and technology, and between task and technology. It does not explicitly consider the fit between user and task, nor between technology and organization. Person-organization fit has been addressed in a number of studies but not incorporated within task-technology fit and vice verse.

ii The TTF does not include attitude elements such as actual usage or intention to use. The TTF model assumes that the user chooses to use technology when it provides benefits such as improved job performance and use will increase regardless of user attitudes towards the technology [95]. Attitude needs to be incorporated together with the task and technology fit construct to better understand users attitude towards adopting technology.

iii The DeLone McLean IS Success Model and the UTAUT model by themselves are excellent models. Each is internally sound and based directly on well-tested attitude behaviour models. Both models define almost similar dependent constructs, in the IS Success Model it is called 'intention to use' or 'use', whereas in the UTAUT model it is called 'behavioural intention'. However, for this dependent construct, each model defines different independent constructs. In the UTAUT model, behavioural intentions are determined by performance expectancy, effort expectancy and social influence. In the IS Success Model, intention to use or use is determined by information quality, system quality and service quality.

iv As stated by Venkatesh *et. al* [34], the UTAUT model was able to explain 70% of intention to use IT while other models explain approximately 40% of technology acceptance. Further, compared to the TAM model which has been vigorously adopted and tested in the health care domain [78], the UTAUT model needs to be further explored for its suitability for predicting general individual acceptance. Although some studies have adopted this model [15, 70], compared to the TAM model, the use of this model is still limited within health care domain. Integrating the UTAUT model together with the IS Success Model and examining them in a single model would provide further support in determining user intention to use technology.

v The limitation of the existing technology adoption models is, the lack of task focus (fit) between user, technology and organization which contributes to the mixed results in information technology evaluation studies [95]. The fit needs to be integrated with existing technology models to better understand issues surrounding implementation of new technology.

vi The importance of considering external factors (exogenous variables) to increase explanatory power on user acceptance studies has been suggested in various studies [77,116]. Along this line, this thesis considers the 'fit' factor as an external factor and proposes this 'fit' as an exogenous construct in the hypothesized model.

vii A number of studies have highlighted the importance of management support and the perception of the user of the security of information provided by the system or software as a factor influencing user decision whether or not to adopt the system or software. These two constructs are not explicitly defined in any of the technology adoption models or existing evaluation frameworks. These two factors need to be addressed to provide better understanding on user acceptance, together with the constructs defined by the UTAUT model and the IS Success model.

viii Although there are studies that integrate TTF with existing technology acceptance model [93, 95, 96, 100], these studies do not include organization fit within the TTF model.

With the purpose to provide a solid theoretical basis for understanding user acceptance, the theoretical model proposes the integration of the UTAUT independent constructs which are performance expectancy, effort expectancy, social influence with the IS Success Model constructs which are information quality, system quality and service quality. Further, as described in Section 2.9 and Section 2.10, the proposed model will also propose to include additional constructs which are Management Support and Information Security Expectancy (ISE). Instead of proposing TTF as an alternative to the UTAUT or the IS Success Model, due to its focus on 'fit' factor, this thesis proposes to add the strength of the TTF model by integrating it with the UTAUT and IS Success Model, which incorporates both attitudes toward information technology and the fit between technology functionality and the characteristics of the tasks that users need to accomplish with the technology together with organization fit.

In the next section, the questions addressed in the evaluation study are reviewed. Existing questions in evaluation studies do not explicitly include the question of 'which'. The following section describes in detail the questions addressed in evaluation studies and review available methods to address the question of 'which'.

2.13 Addressing Evaluation Questions in Evaluation Study

Evaluation outcomes should direct decision makers to take the most appropriate course of action. However, to be able to take appropriate action, decision makers need to know not only factors that contribute towards acceptance but also which among these factors are the most crucial in influencing user acceptance. Knowing the level of importance of each of the factors would help decision makers handle the factors appropriately, rather than focusing effort equally on all. Although there are studies that discuss the critical success factors [9,29], a formal methodology to answer the question of 'which' should be explicitly introduced as an important evaluation question in evaluation studies particularly in user acceptance studies.

Evaluation is carried out to seek answers to the following questions, [1,28]:

1. Why: the objective of evaluation.
2. What: aspects of focus of evaluation.
3. Who: which stakeholder's perspective is going to be evaluated.
4. When: which phase in the system development life cycle.
5. How: methods of evaluation.

2.13.1 Why?

Evaluation of technology is not straightforward as there are a number of challenges to evaluators partly due to the complexity and the nature of the operating environment. Evaluation is carried out for many reasons. Some studies are concerned with users adaptation to the new technology by looking at specific attributes such as user satisfaction [10, 12, 15, 16, 127]. Some studies evaluate the effectiveness of specific health care technology or software implementation [9, 11, 62]. Each evaluation study in health-care is different, depending on the contexts and objectives of the evaluation as set by the evaluators.

One reason why evaluation is extensively carried out is to communicate the findings to the developer of the health care technology application. Developers need to consider the needs as well as the limitations of existing technology from the user perspective and not only based on designers preconceptions on user requirements. Evaluation helps in improving understanding of the role of information technology in health care that offer a wide range of clinical and economic benefits. Thus, evaluation of health information technology is necessary although it is a challenging endeavor. The importance of evaluation as cited by various authors in the literature are given in Table 2.6. Hence, it is generally agreed that implementation of new systems in health care needs thorough evaluation in order to determine its benefits (effectiveness).

Importance of Evaluation	**Ref.(s)**
"Evaluation is challenging as the decision making in design, development, purchase or management in HIS all requires evaluation Evaluation can be used to improve HIS through past experience to identify more effective techniques or methods, investigate failure and learn from previous experience."	[16]
"There is very little evidence to date of the effects and effectiveness of health technologies in normal services. Thus, evaluation is needed."	[128]
"Only a thorough evaluation study can show whether or not a specific system was successful in a specific setting."	[59]
"Effective evaluations of health-care information system are necessary in order to ensure systems adequately meet the requirements and information processing needs of users and health care organization."	[56]
"The assessment outcome of CIS implementation is vital not only to justify the cost within organization but also to promote the national agenda to improve health-care information technology."	[134]
"Even if system is effective when installed, it may rapidly lose its edge as the health system around it changes, making repeated evaluation necessary, to take account of the changing health context."	[28]

Table 2.6: An Overview of Importance of Evaluation

2.13.2 What and Who?

There are usually four major stakeholders who may be interested in the results of the evaluation. Each of these stakeholders has their own concerns and questions on the implementation of the health information technology. Evaluation questions and concerns should cover all relevant stakeholders' perspectives which are the organization, the user of the system, the developer, as well as the patients [28]. Table 2.7 presents some of the concerns that each stakeholder may have [1].

Stakeholder	Concerns/ Questions
Decision Makers	Will the users accept the system?
	How committed are they to use the system?
	Is it worthwhile?
Users	Are all necessary facilities (e.g. training support, network infrastructure, etc.) provided?
	Do I have necessary skills to use the system?
	How useful and easy is it to use the system?
	How safe and secure is the system?
Developers	Has the system met all the user requirements?
Patients	Does the system improve patient care?

Table 2.7: An Overview of Stakeholders' Concerns or Questions

2.13.3 When to Evaluate?

Evaluation can be carried out during any or at all three phases of the system development life cycle which are pre-implementation (development), during implementation, and post-implementation [1, 135]. Most evaluation studies are carried out during the post-implementation phase to investigate the impact of the technology on organizational performance, to the users as well as in the quality of patient care etc.

Grant et. al [129] proposed four different phases of evaluation. Phase 1, involves evaluation of the system design, prototyping, and testing of the functional system and its components. Phase 2, involves evaluating prototypes of the integrated systems at designated sites. Phase 3, involves evaluation after a period of mature use and finally, phase 4 involves continuing periodic evaluation. The objectives of the evaluation determine at which phase the evaluation should take place.

2.13.4 How to Evaluate?

There are two distinct approaches for evaluation mainly objectivist approach and subjectivist approach [1, 28]. The objectivist approach is sometimes known as 'quantitative methods', while the subjectivist approach is sometimes known as 'qualitative methods'. Table 2.8, presents a summary of the differences between these two approaches. The main limitation of the objectivist approach is that it cannot provide an answer as to why or how a system works within a specific setting. If a system fails, the answer will not be provided. The subjectivist approach on the other hand, is said to be able to provide answers for 'why' and 'how' questions [136].

Consequently, many researchers now suggest and use the subjectivist approach when undertaking evaluation work [1,38,132,137]. Ammenwerth and Keizer [51], have developed an inventory of evaluation studies in health-care. According to the authors, in the last 20 years, quantitative evaluation methods such as time measurement, user acceptance measurements, length of stay measurements and error rate scores, have dominated evaluation studies. Qualitative methods are mostly used in explorative studies but seldom in explanative studies (1%).

Objectivist	Subjectivist	Ref.(s)
Objectivist evaluation is an evaluation approach that uses experimental designs and statistical analysis of quantitative data.	Subjectivist approach is an evaluation approach that relies on qualitative data which can be derived from observation, interview, and analysis of documents and other artifacts.	[5]
Objectivist study in which subjects, variables and data collection methods are selected. Objectivist studies is descriptive, comparative or correlation studies	Subjectivist studies which are conducted in natural environment of the subjects without manipulating it and in which themes of interest emerge during the study. Subjectivist studies include case studies. Case studies are empirical in nature and study a phenomenon in its natural context.	[59]

Table 2.8: The Differences between Objectivist and Subjectivist Approach.

2.14 The Question of 'Which'

This section reviews existing methodologies used for identifying, classifying, evaluating and assigning weights to the different decision elements. The five questions discussed in Section 2.13 help in providing guidelines for researchers when conducting evaluation studies. In user acceptance studies, the above questions could be addressed as follows:

i **Why is the evaluation performed ?**

To 'know' whether implementation of information technology or health information systems is successful or will be successful.

ii **What are the aspects or focus of evaluation?**

Identify those factors which influence user acceptance of the technology.

iii **Who are being evaluated and who will be interested with the evaluation result?**
The user usually will be evaluated since success or failure of system implementation largely depends on its acceptance by users of the technology. The results will be of interest to management as well as the developer or provider of the system.

iv **When is the evaluation taking place?**
Depending on which phase the technology or system is at, the evaluation can be carried out prior to full implementation of the technology or after.

v **How will the evaluation be performed?**
A general evaluation could take an objectivistic or subjectivistic approach. Additionally, evaluations could be performed through the development of evaluation models or frameworks.

In order to fully understand user acceptance, it is important to know which among the identified factors are the most influential factors. According to Heathfield et. al [125], evaluation contributes towards the identification of the following:

i ‘what successful implementation of health-care information system is’

ii ‘the factors that influence the defined success’

iii ‘appropriate tools and techniques to measure these success factors’

Table 2.9 provides some examples of published evaluations and shows how the above five questions are addressed. As shown in Table 2.10, the question of ‘which’ in user acceptance study have been addressed **implicitly** using various approaches including linear regression, SEM, SPSS, principal components analysis etc. These are statistical methods which were adopted to test the proposed hypotheses in the study. By answering the hypotheses, it also provides the means to answer the question of ‘which’, however, implicitly.

Author(s)	Why, What and Who (Problem Addressed)	When	How
[138]	To determine physician use of an ambulatory prescription expert system	6 months after implementation	Physician attitude and behaviour survey
[32]	Elderly persons' perception and acceptance of wireless sensor network	Pre-implementation	Focus group with qualitative study
[139]	Measuring effectiveness of electronic medical records systems	After EMR implemented	Cross-sectional survey of five stakeholders
[9]	Mobile Computing acceptance factor in the health-care	Early implementation stage	Snowball and convenient sampling
[33]	Acceptance of health IT applications by caregivers in long-term care facilities	After Implementation	Cross-sectional survey using convenient sampling
[29]	Evaluate the success of Health Risk Reminders and Surveillance (HRRS) system	After Implementation	Questionnaire

Table 2.9: Examples of How Evaluation Questions are Addressed in Evaluation Studies

Reference(s)	The possible question of 'which'
[138]	Analysis of variance (SAS v8.02) and found physician adoption was associated with attitudes towards system efficiency and quality effects but no with computer experiences.
[32]	Transcripts were analyzed and found independence is highly valued and cost may be the most prominent determinant in influencing elderly acceptance of wireless sensor network
[139]	Principal components analysis (PCS) CI and 'use' has the highest r-square value which suggests the effectiveness of electronic medical records highly determined by 'use' index.
[9]	SEM and results suggests self efficacy was explained by a variance of 56 percent, perceived usefulness with 70 percent and perceived ease of use with 65 percent.
[33]	SEM is used and results indicates perceived usefulness, perceived ease of use and computer skills has positive impact with perceived usefulness has bigger impact.
[29]	Linear regression using SPSS statistics program and results shows over four constructs defined, user satisfaction has the highest r-square value of 0.938, followed by system use, R-square = 0.552

Table 2.10: Example of How The Question of 'Which' is Addressed Implicitly

Evaluation is conducted to identify factors that influence user intention to use a particular technology. Various methods have been used to answer the question of 'which'. For example, Schectman et. al [138] has listed factors that determine physician use of expert systems and in this study the author uses SAS software to analyze the factor. The results suggested the importance of system efficiency and quality of user acceptance as the influential factors of expert system acceptance.

Although factor identification helps the management to address problems and reduce the risk of technology being 'rejected' by the user, this alone is insufficient for success. The outcomes of an evaluation should also identify which factors are the most crucial in influencing user acceptance. Consequently, decision makers can handle those factors most appropriately. Thus, the researcher believes evaluation of user acceptance of technology should incorporate explicitly the question of 'which' in the study.

Apart from various statistical methods available to answer the question of 'which' as shown in Table 2.10, this thesis reviews another approach which could equally provide a platform to answer the question of 'which', called Multi-Criteria Decision Analysis (MCDA) techniques.

2.15 Multi-criteria Decision Analysis (MCDA) Techniques

MCDA is a discipline which aims to support decision makers when they are faced with various conflicting evaluation items. MCDA techniques provide a mean to identify the most preferred option, through weighting and ranking of decision elements. As stated by Dolan [140] some of the advantages of MCDA are :

- *“MCDA helps people to make better choices that are consistent with their preferences and value”*
- *“MCDA useful in a situation that involve two or more decision makers, a mixture or tangible and intangible consideration or both”*

Various MCDA methods are available, such as the Analytic Hierarchy Process (AHP), Goal Programming (GP), Fuzzy AHP, Data Envelopment Analysis (DEA), Multi-attribute utility theory, Scoring methods, Electra, and many more . All these decision methodologies are differentiated by the way the objective and alternative weights are determined, as prescribed by axiomatic and/or rule-based structures. The following subsection discusses 2 of widely used MCDA techniques as decision tool which are AHP and Fuzzy AHP.

2.15.1 Classical AHP Approach

Among other known MCDA methods, Analytic Hierarchy Process (AHP) is one of the most widely used multiple criteria decision-making tools. Analytic Hierarchy Process (AHP) is used for dealing with problems that involve the consideration of multiple criteria simultaneously. Since its introduction in 1977 [141], AHP has been widely used as a multiple criteria decision-making tool. The use of AHP does not involve cumbersome mathematics, but uses principles of decomposition, pairwise comparison, and priority vector generation and synthesis. The AHP technique was developed in 1977 by Thomas L. Saaty who derived the ‘theory of prioritised hierarchies’ [141]. AHP is known as a theory of measurement; when used in decision making process, it provides a mean to general decision operation by helping to decompose a multi-criteria decision problem into a multi-level hierarchical structure of objective, criteria, sub criteria and alternatives [140, 142, 143]. In a basic hierarchy, the top upper level represents the overall objectives of the decision problem. This is followed by the elements which affect the decision in the intermediate level. The lowest level comprises the decision options. In this thesis, the goal is to obtain the ranking for each user acceptance factor. To achieve this goal, this thesis identifies the criteria to measure as technology, user and organization factors. Each criteria is further decomposed into several sub-criteria as shown in Figure 2.9. AHP is based on three principles which are decomposition of decision problems, comparative judgments of preferences and synthesis of priorities.

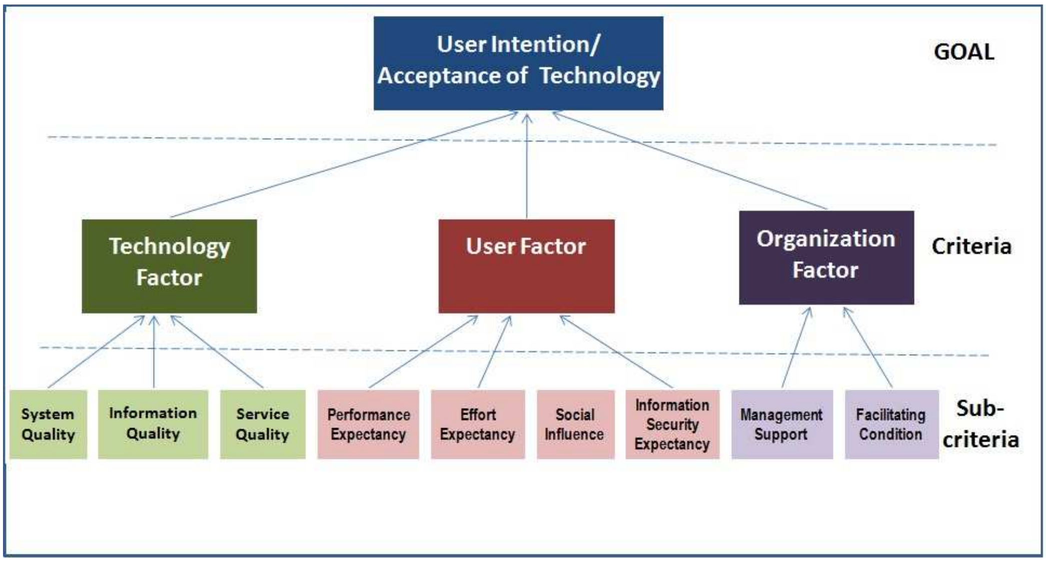


Figure 2.9: The hierarchy of Decision Problems

Fundamental resolution of a multi-criteria problem using AHP is the process of determining the weights of various criteria and find the solution weights of decision elements based on the criteria. As stated by Bodin and Gas [144], *"as the true weights are unknown, they must be approximated"*. In order to do so, the AHP requires answers, which could be numerical or verbal, to a sequence of questions that compare two criteria [144]. The input to the AHP is the decision maker's answers to a set of questions, for example, 'How important is criterion X relative to criterion Y?'. Decision makers are required to compare X and Y at the same time and decide which is the best option over the other. This is known a pairwise comparison. When decision maker answers question based on pairwise comparison, they estimates the true weight (but unknown weigh) which is based on their experience and insight relative to the decision problem. According to Salmeron and Herrero [142], making pairwise comparisons is believed to be more reliable way of obtaining the actual weights than obtaining them directly because in general it is easier to evaluate the relative weights of each attributes in comparison to the others. Responses or answers to the questions are gathered in verbal form which are then matched with a nine-point intensity scale. The intensity scale ranges from equal to extreme (equal, moderately more, strongly more, very strongly more, extremely more) and corresponding to its numerical judgments (1,3,5,7,9) and intermediate value between these values [3]. This is shown in table 2.11 below [3].

Intensity of importance	**How Important is option X relative to option Y?**
1	Equally Important
3	Moderate importance
5	Essentially or strong importance
7	Very Strong Importance
9	Extreme Importance
2,4,6,8	Intermediate values between two adjacent judgments
Reciprocals	If option x has one of the above number assigned to it when compared to option y, then y has the reciprocal value when compared with x

Table 2.11: The Intensity Scale and Associated Numeric Judgments

Basic steps involved in this AHP methodology are as follows [145]:

1. State the problem.
2. Broaden the objectives of the problem or consider all actor, objectives and its outcome.
3. Identify the criteria that influence the behavior.
4. Structure the problem in a hierarchy of different levels constituting goal, criteria, sub-criteria and alternative.
5. Compare each element in the corresponding level and calibrate them on the numerical scale. This requires $n(n-1)/2$ comparisons, where n is the number of elements with the considerations that diagonal elements are equal or 1 and the other elements will simply be the reciprocals of the earlier comparisons.
6. Perform calculations to find the maximum eigen value, consistency index CI, consistency ratio CR and normalised values for each criteria.

7. If the maximum eigen value, CI and CR are satisfactory then decision is taken based on the normalised values; else the procedure is repeated till these values lie in a desired range.

According to Saaty [3], in a general decision-making environment, it would be expected that the estimates of the unknown weights, which is reflected by weight estimation (ratio) given in answer to the pairwise comparison, could suffer inconsistency. Therefore, in order to check for inconsistency, Saaty suggests a measure of inconsistency called consistency ration (CR) [3]. This consistency ration (CR) is based on fundamental theoretical results on the size of the largest eigen value for the matrices in the study . The consistency ration (CR) values range from zero (zero indicate true consistency of the input) to a very large positive number. If IR is 0.10 or less (10%), the decision matrices should be accepted else if CR is above 0.10, the decision maker needs to rethink the input and try to find any anomalies in the comparisons [3].

As shown in the above steps, the final weights for the alternatives are formed by the summed product of various elements, with the resultant weights normalised ratio-scale numbers and these weights are unit free [144]. The resultant weights are ratio-scale numbers; the unique feature of AHP. The weights produced allow the decision makers to compare between two decision elements. For example, if X produced a weight of 0.340 and Y produced a weight of 0.170 and we can conclude that X is twice as preferred as Y.

In other scientific disciplines, multi-criteria decision analysis particularly AHP has gained widespread acceptance [145]. According to Liberatore and Nydick [146], the main uniqueness of AHP is its inherent capability to weight a large number of different factors, of different natures, including both qualitative and quantitative data, in order to make a decision based on a formal and numerical process. Vaidya and Kumar [145] conducted a review on the application of AHP and the results shows that AHP is being pro-dominantly used in the area of selection and evaluation, mostly in engineering, personal and social categories, assessing factors affecting the electronic marketplace [147], accessing critical factors for total quality management in manufacturing industries [143], assessing critical success factors of executive information systems [142] and many other scientific fields .

As AHP became an established technique, many combined methods were experimented and used. This, however, does not mean that AHP is no longer a stand-alone model. Large numbers of researchers are still using AHP as a stand-alone tool to address problem domains. AHP is a flexible tool that is able to be combined with many different techniques effectively. Badri [148] studied combining AHP with a Goal Programming method. Goal Programming (GP) is a mathematical technique and a variation of linear programming which is capable of handling decision-making problems which have multiple and conflicting goals. These two techniques were combined to model quality of control systems. After assigning weights to the various locations, a GP model was formulated to select the best combination of alternatives based on resource limitations such as budget, and then used to determine the allocation of products from locations to distribution centers. Further, Lee and Kwak also applied AHP methods integrated with goal programming to facilititate decision-making planning and process in health-care information resource planning [149]. Kwong and Bai [150] for example, combined AHP with Quality Function Deployment (QFD) and applied the combined AHP-QFD approach to aid new product development. They argued that the normal pairwise comparison in the general AHP which was suggested by Saaty [151] seemed to be insufficient and too imprecise to obtain the relative importance weightings of the customer requirements and so introduced the use of fuzzy numbers in pairwise comparisons.

Fuzzy based multi attribute decision making (FMADM) methods were developed due to uncertainty or imprecision in assessing the relative importance of decision elements and the performance ratings of alternatives with respect to the attributes. Traditional methods such as AHP are not believed to be able to handle problems with such imprecise information. This is resolved by adapting the fuzzy set theory introduced by Zadeh in 1965 [152]. This theory attempts to select, prioritize or rank decision elements by evaluating a group of predetermined criteria or alternatives. The linguistic terms that people use to express their feelings and judgment are vague. To address this issue, the widely adopted triangular fuzzy number technique is used to represent the vagueness of these linguistic terms. Various approaches are available which apply the triangular fuzzy number approach to crisp value. There are several fuzzy AHP methods and each method has its own advantages and disadvantages as shown in Table 2.12 (adapted from [153]). These methods are differentiate in terms of their theoretical structures.

Sources	The main characteristics of the method	Advantages (A) and Disadvantages (D)
Van Laarhoven Pedrycz [154]	Direct extension of Saaty's AHP methods with triangular fuzzy number.	(A) The opinion of multiple decision-makers can be modeled in the reciprocal matrix
	Lootsma's logarithmic least squares method is used to derive fuzzy weights and fuzzy performance scores.	(D) There is not always a solution to the linear equation.
		(D) The computational requirement is tremendous, even for a small problem
		(D) It allows only triangular fuzzy numbers to be used
Buckley [155]	Extension of Saaty's AHP method with trapezoidal fuzzy numbers.	(A) It is easy to extend to the fuzzy case.
	Uses the geometric mean method to derive fuzzy weights and performance scores	(A) It guarantees a unique solution to the reciprocal comparison matrix.
		(D) The computational requirement is tremendous
Boender *et. al* [156]	Modifies van Laarhoven and Pedrycz's method	(A) The opinion of multiple decision-makers can be modeled.
	Presents a more robust approach to the normalization of the local priorities.	(D) The computational requirement is tremendous.
Chang [157]	Synthetical degree values	(A) The computational requirement is relatively low
	Layer simple sequencing	(A) It follows the steps of crisp AHP. It does not involve additional operations.
	Composite total sequencing	(D) It allows only triangular fuzzy numbers to be used
Cheng [158]	Builds fuzzy standard	(A) The computational requirement is not tremendous
	Represents performance scores by membership functions	(D) Entropy is used when probability distribution is known. The method is based on both probability and possibility measures.
	Uses entropy concepts to calculate aggregate weights	

Table 2.12: The Comparison of Different Fuzzy AHP Methods

2.15.2 Fuzzy AHP: Chang's Method

AHP is a method for ranking decision alternatives and selecting the best when the decision maker has multiple criteria. With AHP, the decision maker selects the alternatives by developing a numerical score to rank each decision alternative based on how well they match his or her decision criteria through comparison ratios. Many publications address the situation where the comparison ratios are imprecise judgments [154, 159]. As stated by Chang [160], *"in many practical situations, the human preference model is uncertain and decision makers might be reluctant or unable to assign exact numerical values to the comparison judgments"*. Further, the author added *"AHP is ineffective when applied to ambiguous problem"*. To address this issue of ambiguity in decision making, some authors suggest combining Fuzzy theory with AHP. It is believed that combining fuzzy set theory with AHP (fuzzy AHP) allows for a more precise description and representation of multiple-items decision making process [161].

Linguistic Scale	**TFN**$_{ij}$
Absolutely More Important	(7,9,9)
Much More Important	(5,7,9)
More Important	(3,5,7)
Slightly More Important	(1,3,5)
Equally Important	(1,1,3)

Table 2.13: The Linguistic Scale and Associated Fuzzy Triangular Number

The earliest work using fuzzy AHP is by Laarhoven and Pedrycz [154]. This study compared fuzzy ratios described with triangular fuzzy numbers.

According to Chang [160], the uncertainty in the preference judgments gives rise to uncertainty in the ranking of alternatives as well as difficulty in determining the consistency of preferences. Despite the convenience of AHP in handling both quantitative and qualitative criteria of multi-criteria decision making problems based on decision makers' judgments, the fuzziness and vagueness existing in many decision-making problems may contribute to the imprecise judgments of decision makers in conventional AHP approaches.

Given the subjective and qualitative nature of some service evaluation criteria, decision makers find it extremely difficult to express the strength of their preferences and to provide exact pair-wise comparison judgments. It was believed that conventional AHP did not reflect natural human thinking [160–162]. In order to avoid these risks on performance, fuzzy AHP (FAHP), a fuzzy extension of AHP, was developed to address hierarchical fuzzy problems. Instead of using crisp value, preferences judgments are represented as fuzzy number as shown in Table 2.13. Within the health-care domain, the adoption and use of multi-criteria decision analysis is limited particularly in the study of user acceptance of health-care technology.

2.15.3 Fuzzy AHP: α and λ method

Fuzzy AHP: α and λ method is another FMADM method. Csutora [163] came up with a Lamda-Max method, which is a direct fuzzification of the well-known λ max method. Similar to Chang's method, this method also explicitly expresses fuzzy perceptions. This method is differentiated from others through the use of a preference α and a risk tolerance λ of the decision maker [162].

A number of studies adopted this method as a decision support tool. Chang [160] for example applied this method to evaluate appropriate DVR systems. The evaluation criteria consists of various elements such as functionality, reliability, usability, efficiency, maintainability and portability. Four DVRs were evaluated using this approach, the results of which enable decision makers to identify the most appropriate DVR systems. Lin et. al [162] evaluated factors influencing knowledge sharing in the Taiwaness shipping industry. 16 attributes were evaluated and these attributes were categorised within four dimensions which were corporate culture, employee motivations, leaderships and information technology.

Chang et. al proposed the following steps in employing this method [160]:

- Step 1: Establish a hierarchy framework
- Step 2: Select experts for assessment.
- Step 3: Establishment of triangular fuzzy numbers.
- Step 4: Perform defuzzification
- Step 5: Calculate the eigenvalue and eigenvector
- Step 6: Test the consistency
- Step 7: Computing the weight of alternatives
- Step 8: Final decision making

This thesis found very little on the application of Fuzzy AHP: α and λ within the health informatics research area particularly on user acceptance of health care technology. The above two types of Fuzzy AHP methods are adopted in this thesis to assign weights between various user acceptance factors in this thesis. The application of these two types of Fuzzy AHP, to the best of researcher knowledge, is quite limited.

2.15.4 Comparison between AHP and Fuzzy AHP

Each of the above techniques has its own strengths and weakness as shown in Table 2.14. These comparison have been adapted from several publications [150, 164, 165].

	Analytic Hierarchy Process (AHP)
Strength	Provides a formal multi-criteria decision-making mechanism for ranking the factors by collecting user's perceptions about the importance of the factors.
	The procedures to build the hierarchy are fairly simple and easily understood even in group decision making when diverse expertise and preferences are involved.
	The decision problem is presented as graphical hierarchical structures which may simplify potential risk and conflict.
Weakness	Difficulties may arise when a user has to deal with a large number of factors which can lead to inconsistency in providing the estimation of the importance among the factors.
	In some cases the ranking of the alternatives can be reversed when a new alternative is introduced (Rank Reversal Problem).
	The fuzziness and vagueness existing in many decision-making problems may contribute to the imprecise judgment of decision makers.
	Fuzzy Analytic Hierarchy Process (FAHP)
Strength	Able to deal explicitly with the vagueness and uncertainties in AHP.
	The decision problem is represented as graphical hierarchical structures, easy to understand.
	Use of triangular numbers to represent subjective pairwise comparison of factors in order to capture the vagueness.
	Can allow the user to have freedom of estimation regarding the weight of the factors under study, so that their judgment can range from optimistic to pessimistic.
Weakness	In many methodologies introduced by various authors, it is difficult to find a consistent process for determining fuzzy inputs and crisp weights,
	given that the consistency index method is not appropriate because of the fuzziness.
	Fuzziness itself may have some bias, including decision maker's inconsistency

Table 2.14: The Strengths and Weaknesses of AHP and Fuzzy AHP

2.16 AHP and Fuzzy AHP as Decision Support Tool

Within the medical and health care sectors, AHP has been used quite extensively. Liberatore and Nydick [146] conducted a literature review of the application of the analytic hierarchy process (AHP) in medical and health care decision making. The review shows that AHP is largely used in the project and technology evaluation and selection category, followed by patient participants, therapy/treatment and health care evaluation and policy.

Rossetti and Selandari [166] for example used AHP for multi-objective analysis of middle to large sized hospital delivery systems. It was evaluated to check whether a group of robots could replace human-based delivery, transportation and distribution services. Five factors were considered for evaluation which were technical, economic and social, human and environmental. Singpurwalla et. al [167] used AHP as a tool to facilitate decision making of two specific health care populations. The use of AHP helped to improve physician-patient communication by assisting shared health decisions, and helped the patients to evaluate and understand their health care options rather than relying completely on the doctor's decision. Further, Topacan et. al [168], evaluated health information service attributes using the AHP approach. Sloane et. al [169] applied AHP to an interactive, multidisciplinary, microeconomic health technology assessment. The results demonstrated the success of AHP as a decision tool to support a hospitals purchasing negotiation. Hariharan et.al [170] applied AHP as a tool to measure and compare the global performance of intensive care units. The success factor criteria included process, structure and outcome.

Further, MCDA particularly the AHP approach has been used to promote shared decision making and enhance clinician-patient communication by developing a framework which could be used to define the decision, summarize the information available, prioritize information needs and elicit preferences and values [140]. All these studies show the applicability of MCDA as a decision support tool which could help the decision makers to select the best option or alternatives when there are several to consider. Although the suitability of AHP to assign weights between decision elements has been shown in number of studies [166–168] some authors have combined this method with others.

Ho [171] conducted a review on integrated AHP approach together with its applications. A total of 66 journal articles were reviewed and showed that the most popular tool integrated with the AHP is mathematical programming. The most popular application area for integrated AHP is logistics (21) followed by manufacturing (18), government (4) and higher education (4). Within the healthcare domain, only 2 works were found that applied AHP with other tools. Ho [171] suggested that integrated AHPs are better than the stand-alone AHP. Although studies have combined AHP with other techniques to better represent the decision making process and support, the AHP method has been proven as a decision support tool.

The popularity of AHP and Fuzzy AHP as decision support tools were evident from numerous publications in multiple disciplines. Table 2.15 presents examples of studies that have employed AHP and Fuzzy AHP as decision support tool.

Aspects of Evaluation(s)	**Methods**	**Ref. (s)**
Critical Factors for total quality management (TQM) implementation in manufacturing industries	AHP	[143]
Information System Project Selection	AHP	[172]
Experimenting the use of AHP as s tool for decision making	AHP	[167]
Assessing success factor for implementing concurrent engineering (CE)	AHP	[173]
Critical Success Factors of Executive Information Systems	AHP	[142]
User Acceptance of Environment-friendly Car	Extended AHP	[174]
Evaluation of Health Information Service Attributes	AHP	[168]
Health technology assessment	AHP	[169]
Monitoring health care performance	AHP	[175]
Factors influence Adoption of Electronic Marketplaces	AHP	[147]
Modelling IT Project Success	Fuzzy Cognitive Maps	[176]
Measuring and Comparing the Global Performance of Intensive Care Units	AHP	[170]
Investigating AHP as a tool to facilitate decision making	AHP	[167]
Evaluating digital video recorder systems	AHP, Analytical Network Process	[54]
Critical Success Factor for Information Service Industry in developing international market	AHP	[177]
Measuring process-based performance of multi-specialty tertiary care hospital	AHP	[178]
Customer Requirements in Quality Function Deployment	Fuzzy AHP	[150]

Table 2.15: Example of Studies Applying AHP and Fuzzy AHP Method

These examples clearly show the suitability of AHP and Fuzzy AHP in addressing problems which involves multiple decision making elements as well as conflicting goals. Although there are number of studies on user acceptance [174,179], studies on user acceptance within health informatics which use the MCDA approach particularly Fuzzy AHP, to the best of researcher knowledge is quite rare. Knowing the level of importance of decision elements i.e factors that influence user acceptance would help the management to take the most appropriate course of action.

2.17 Gaps in the Knowledge (Second Part of Research)

To date, the application of AHP and Fuzzy AHP to guide implementation factors in health care is rare. The following observations are made from the literature on MCDA, for the second part of research:

1. The trend on utilizing fuzzy AHP in published papers continues in many disciplines in multiple themes. However, within the health care domain, particularly in evaluation studies on user acceptance of health care technology, this method is not widely employed or examined.

2. The applicability of MCDA to answer the question of 'which' is an interesting question to be explored.

3. Despite the claims by many authors on the limitation of AHP, Saaty [180] claimed that AHP and Fuzzy AHP do not make any differences in ranking, further Fuzzy AHP is more mathematically consuming. This statement provides further motivation to apply both AHP and Fuzzy AHP and to compare the results obtained. Based on the results obtained, the applicability of MCDA approaches to explicitly answer the question of 'which' within evaluation study will be discussed.

2.18 Summary

Chapter 2 established the foundation of this thesis by reviewing evaluation studies and limitation of existing evaluation frameworks to incorporate the fit between user, technology and organization as a core determinant to those factors defined by various technology adoption models.

In analyzing the related literature, it shows that the relationship in this thesis which is the influence of perceived fit between user, technology and organization with the constructs defined by the UTAUT model and the IS Success Model has not been tested in any existing evaluation study. Further, the TTF model, UTAUT and the DeLone McLean IS Success Model, have not been previously examined as a single integrated model (discussed further in **Chapter 3**) which is proposed in this thesis.

Further, the inclusion of 'management support' and 'information security expectancy' as important variable are proposed as the theoretical model to better understand user intention to adopt new technology. The fact that there could be other variable than these two, this research believed that these variables are not tested together with an integrated model, in any previous study and possible to answer research questions outline in **Chapter 1**.

To provide foundation for proposing the theoretical model, a discussion on the existing technology adoption models was presented. This was followed by reviewing user acceptance studies, the importance of 'fit, and models related to 'fit' factor. This was followed by reviewing existing evaluation frameworks from a 'fit' perspective to provide better understanding of the role of 'fit' in the proposed model of this thesis.

This thesis also discussed the existing evaluation questions in evaluation studies. These are the questions of why, what, who, when and how. Multi-criteria decision analysis (MCDA) techniques as a method to assign weights between various decision elements were discussed to provide a platform to answer the question of 'which' proposed in this thesis. Two widely-known and widely used techniques, AHP and Fuzzy AHP were elaborated and their application within various disciplines were reviewed. Within the health care domain, the use of AHP has been recognised in a number of studies however to the best of the researcher's knowledge the use of Fuzzy AHP, particularly to assign weights between decision elements is limited. Therefore, both AHP and Fuzzy AHP are adopted to provide the means to assign weight between decision elements and its applicability in answering proposed research question posed in **Chapter 1** will be examined in this thesis.

In the next chapter, the proposed theoretical model and its hypotheses are established to be empirically tested in this thesis.

Part I

Exploring New Factors

Chapter 3

Proposed Theoretical Model of User Acceptance of Health care Technology

3.1 Introduction

Chapter 2 discussed the foundation for this thesis which proposes to include a construct of perceived fit between user, technology and organization, management support and information security expectancy within a user acceptance model. **Chapter 3** discusses the development of the proposed theoretical model to be analyzed as well as the hypotheses to be tested. The theoretical model is tested among medical students on their intention to use medically related software. This chapter is organized into 8 sections. The first section is an introduction, followed by Section 3.2 which describes the phases involved in the development of the proposed theoretical model. This is followed by Section 3.3 which provides an overview of the proposed model, to examine the research questions proposed in **Chapter 1**. Section 3.4 discusses the proposed construct; perceived user-technology-organization fit (PUTOF) of this thesis. This is followed by Section 3.5 which discusses the relationship between PUTOF with constructs defined by the UTAUT model. Section 3.6 discusses the relationship between PUTOF with those constructs defined by the DeLeon McLean IS Success Model. Further, Section 3.7 discusses the linkage between PUTOF with Management Support and Information Security expectancy constructs as well as the linkage between these two constructs with user intention to use. The final Section 3.8 presents a chapter summary.

3.2 Phases Towards Development of the Theoretical Model

Two phases contributed towards the development of the proposed theoretical model of this thesis. The following sub-sections discuss in details these phases.

3.2.1 Phase 1: Meeting with the Users of the Distiller Software

The thesis work was initially developed from investigating factors contributing towards acceptance of Distiller Software. A meeting was held with a clinician who agreed to be part of the research work. The Breast Cancer Pathology Research group in Queens Medical Centre (QMC), Nottingham, has purchased a new piece of software known as *Distiller* [181]. This software has been actively used by the research students for almost a year since its introduction in 2007. The *Distiller* software is basically a web-based data collection and management tool which can be used in a wide variety of laboratory and clinical research setting to manage histopathological data, including image data. It also provides facilities to clinically assess the data, such as online scoring of the histological images. The first meeting with the Andrew Green, Senior Research Fellow based in the Division of Pathology, School of Molecular Medical Sciences, who is responsible for the purchase of the software, took place in April 2008. The objective of this meeting was to get an overview of the software used by the Pathology Research group. Further to this meeting, communication was made with the *Distiller Company* to get more information about the software as well as informing them of our intention to evaluate their software by looking at the user acceptance level.

In August 2008, a follow-up meeting with Dr. Andrew Green, took place in his office at Queens Medical Centre (QMC), Nottingham. The meeting was audio-taped and contemporaneous field notes were transcribed. A list of research students using the software was used to facilitate meetings with students. Prior to scheduling meetings, a presentation was given in the routine breast cancer pathology meeting on 24th September 2008. The aim was to communicate the research aim and objectives and also to seek students' cooperation in participating in the study.

Following from this, emails were sent to secure face-to-face interviews with students. 4 students agreed to be interviewed. The first meeting was held in the Molecular Medical Science Teaching Facility Room in Queens Medical Centre on 2nd November 2009. Using *face-to-face interviews in a free format* [182] lasting approximately 45 minutes, four students were interviewed on their opinion of the *Distiller* software and factors influencing their usage of the software. The data were hand-recorded and audio-taped. Appendix A shows the detailed field notes based on trigger notes. Transcripts were reviewed within 24 hours of the interview [182, 183]. At the end of this phase, a list of factors mentioned by the users was compiled and is shown in Table 3.1 below. The table shows both positive factors and negative factors. These interviews formed the first foundation to build the proposed theoretical model.

User 1
easy to use, save time, interaction clear, improved job performance, influence by colleagues, have necessary facilities, support from supervisor, never experienced data crashed, up-to-date data, functionality fine, training not necessary, problem with network (slow speed), not enough ‘zooming’ option, need more level of authorization to use the software, help desk not helpful
User 2
user-friendly, save time, interaction fine, improve job performance, not influenced by other colleagues, enough security features, supervisor very supportive, never experienced data crashed, not necessary to attend training, functionalities fine server slow, speed slow, help desk not very helpful
User 3
easy to use, user-friendly, interaction clear and understandable, use not influenced by other, get support from supervisor, training is not important, functionality provided by the software is fine, up-to-date data, has right level of authorization to use the software, help desk support was fine but not all all time software does not save time as downloading and uploading of the images was slow, it did not improve job performance, do not have necessary facilities to support the use of software, slow Internet connection, experienced data crashed several times, slow speed, not confident with the quality of software in terms of images produced by the software.
User 4
easy to use, user-friendly, save time, interaction clear, improved job performance, not influenced by other colleagues, have all the necessary functionalities, support from supervisor, good quality software sometime experienced data crashed, functionality could be increased, not enough security, not a good help desk support from the software provider

Table 3.1: Factors Associated with the Acceptance (Usage) of the *Distiller Software*

3.2.2 Phase 2: Reviewing and Compiling User Acceptance Factor

The lists of factors associated with the use of *Distiller Software* was further scrutinized to reveal items of agreement or disagreements between participants. Observations were made as follows:

- The software is easy to use however not all users agreed that the use of software improved their job performance.
- Except for one user (user 1), the use of software was not influenced by other colleagues.
- Two students experienced data crashes.
- Three students were happy with the level of authorization they were given to access and use the software, however one student would have liked more access to the software.
- All students experienced network problems in terms of speed and were not happy with the help desk support.
- All students had received support from their supervisor to use the software.

The above observations show that although all the research students used the software, the factors associated with their acceptance and use of software were quite different. For example, although almost all respondents agreed that use of the software improved their job performance, one user disagreed and said that the use of the software had increase the time needed to complete the research work. This clearly illustrate the differences in 'fit' between user and software even though the same software is being used. Improvement in job performance perceived by the user is one of the constructs defined in the UTAUT model where it is called 'performance expectancy'. The outcome from this study suggests that the construct 'performance expectancy' on its own could not determine user intention to use software or technology. The effect of performance expectancy on intention to use depends on how the user perceives he or she 'fits' with the software.

The objective of second phase was to examine if it is possible to categorize factors identified from literature together with factors compiled from phase 1, within the existing technology adoption model particularly within constructs defined by the UTAUT model and the DeLone McLean IS Success Model as shown in Table 3.2.

Model	Construct	Factors
UTAUT	Performance Expectancy	Improve Job Performance, Save time
UTAUT	Effort Expectancy	Easy to use, user-friendly, Clear interaction
UTAUT	Social Influence	Influenced by other colleagues
UTAUT	Facilitating Condition	Network (slow speed)
IS Success Model	Software Quality	Up-to-date data, good quality, data crashed
IS Success Model	Information Quality	Understandable, good output
IS Success Model	Service Quality	Not good help desk support

Table 3.2: Categorization of the Factors According to UTAUT and IS Success Models' Construct

The results shows several factors mentioned by the students (listed in Table 3.1) could not be categorized within any of the constructs defined by the UTAUT Model and the IS Success Model.These are *support from supervisor*, *not enough security*, *need more authority to access the software*, *access in terms of level of authorization* and *has right level of information security*. This work provides support, additional to that from the literature (described in section 2.9 and section 2.10), to introduce the constructs 'management support' and 'information security expectancy' within the proposed theoretical model. In the context of this study, the support from supervisor is categorized as management support since the supervisor is the one who is responsible for introducing the software to the students.

3.3 Proposed Theoretical Acceptance Model

As presented in **Chapter 1** and **Chapter 2**, this thesis focus on understanding of the relationship between perceived user-technology-organization fit with those factors that influence user acceptance of health care technology. Furthermore, three models have been integrated into one single relationship model with the addition of two new constructs. This thesis seeks to contribute to the body of knowledge in user acceptance studies by examining the integrated model as an important determinant of user acceptance factors. Based on the literature review in **Chapter 2**, Figure 3.1 shows the proposed conceptual framework in this study. This proposed model was developed after reviewing existing models and theories of user acceptance (see section 2.5), evaluation dimensions (see section 2.6), related 'fit' models (see section 2.6.2) and existing evaluation frameworks (see section 2.11). In order to minimize the weaknesses and maximize the strengths of the IS Success Model, the UTAUT Model as well as the TTF Model, these models are integrated and tested as a single model. These three models have been were well-tested and validated in various studies [15, 34, 70, 82].

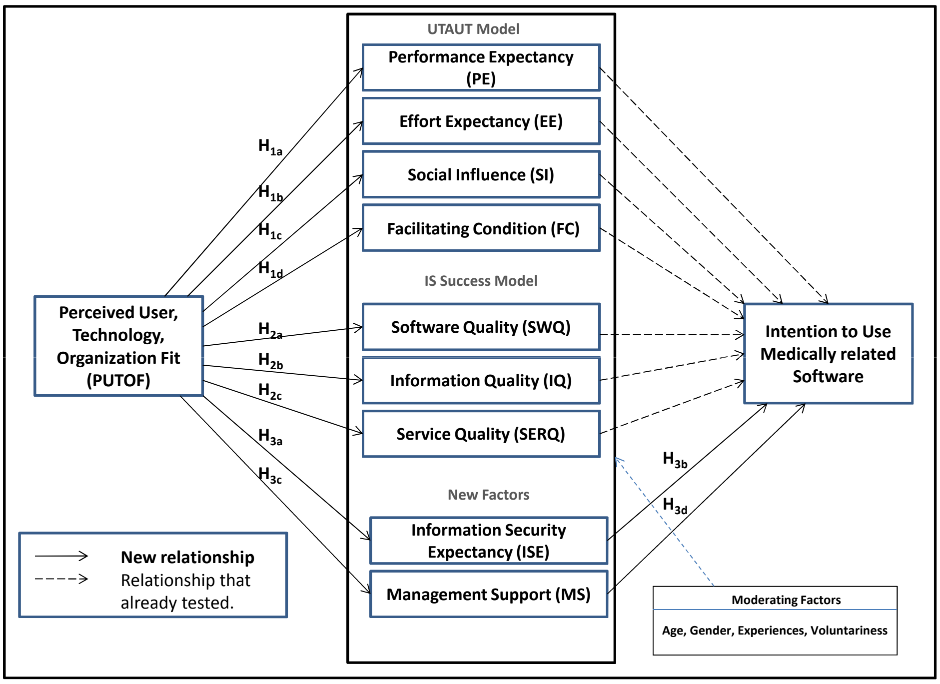


Figure 3.1: Proposed Theoretical Model of User Intention to Use Health care Technology

Figure 3.1 shows the 11 hypotheses that will be tested in this thesis. Hypotheses (H_{1a}, H_{1b}, H_{1c}, H_{1d}) reflect the influence of the perceived user-technology-organization fit (PUTOF) construct (comprise of relationships between user and technology, user and organization, technology and organization) on constructs defined by the UTAUT model. Hypotheses (H_{2a}, H_{2b}, H_{2c}) identify the relationship between the PUTOF construct with constructs defined by the IS Success Model. Hypotheses (H_{3a}, H_{3b}, H_{3c}, H_{3d}) further explore the linkage between PUTOF with management support (MS) and information security expectancy (ISE) constructs and the linkage between these two constructs with the intention to use construct.

Various studies have pointed out that external factors will have direct effects on perceived ease-of-use and usefulness [116, 184, 185] and this thesis proposes perceived user-technology-organization fit (PUTOF) as an external factor and as a core determinant of those factors that influence user intention to adopt or use technology. In addition to the factors or constructs suggested by UTAUT and the IS Success Model, two new constructs are added into the proposed theoretical model which are information security expectancy (ISE) and management support (MS). Thus, the proposed model has one exogenous variable which is perceived user-technology-organization fit (PUTOF) and 10 endogenous which are performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating condition (FC), software quality (SWQ), information quality (IQ), service quality (SERQ), information security expectancy (ISE), management support (MS) and intention to use (ITU).

The proposed hypotheses in this study are newly examined hypotheses which have not been examined in previous studies. Further, this study does not intend to explain the intention to use technology to the same extent as the original UTAUT, the DeLone and McLean IS Success Model and the TTF model because vast studies have already addressed these relationships [68, 70, 100, 186], which are shown as dotted line in Figure 3.1. Only the left-hand side of the UTAUT Model and IS Success Model are tested with PUTOF. It is hypothesized that PUTOF could have a significant effect on these left-hand side constructs. However, for the new constructs, MS and ISE, their relationships with intention to use technology are fully examined in this thesis. These new hypotheses were shown as solid lines in the model (see figure 3.1).

Moderating factors such as age, gender, experiences and voluntariness are not tested in this study. Depending on the environment in which the system or technology is implemented, these moderating factors may or may not have direct influence on user intention to use technology. Various studies have shown various effect of moderating factors such as age, gender and experience on user acceptance [15, 33, 60, 187]. A study by Ayatollahi et. al [52] for example shows that age on its own did not influence user acceptance of information systems but other factors such as users' computer knowledge and users' experiences of technology together would have an influence on user acceptance. A study by Laerum et. al [44] shows that computer literacy and computer use have no correlation with respondents' age, sex or work position. Existing studies show the influence of moderating factors vary depending on the technology being investigated, the setting and the user of the technology. Furthermore, the moderating factors proposed by the UTAUT model which are age, experience, gender and voluntariness have little influence in intention to use, in the context of this thesis. This is because the sample in this thesis are medical students where, for example, age and experiences between medical students may not vary to much as compared to real user of the technology or software. Therefore, this thesis does not investigate the influence of moderating factors on user acceptance of technology.

3.4 Perceived User-Technology-Organization Fit (PUTOF)

Goodhue [30] suggests that the degree of task-technology fit is the capabilities of the system to match the task that the user must perform and unless the technology meets the requirements of the job, people will not continue to use the technology [30, 84]. This is supported by Alter [188]. A number of studies suggest that user's perception on whether or not a particular software or technology fits well with their present values and is able to provide user benefits to them could influence their perception of using that particular technology [19, 93, 94, 96, 100]. For example, Dishaw and Strong [95] incorporate task-fit into the technology acceptance model and suggests that task fit has a positive impact on a user's perception of the ease of use. Moreover, when the technology meets the task users' needs, it will increase the utilization of that particular technology [100]. Most of these studies make use of the TTF model to describe the user acceptance issue. However, TTF model only describes the importance of fit between task and technology. Fit between task and technology together with the organization fit should be equally addressed, which is vital in understanding user acceptance factors. This can be understood from a **person-organization fit theory**. Person-organization fit refer to the compatibility between people and organization which look at the extent to which an individual and the organization share similar characteristics [31]. According to Ahmed et. al. [189], a good fit between the person and the organization is essential for a better organizational performance. Findings by Vest [66] suggests that hospitals with lower technological readiness had lower adoption, which illustrates the absence of fit between user, technology and organization. The impact of organization fit could also be understood from **contingency theory** [190, 191]. This theory argues that if the user perceives that a particular technology can increase an organization's performance, although it does not fulfill the task they need to perform, the user is possible to alter their values or beliefs to fit the organization objective [192]. This essentially means that users would evaluate particular technology not only on how well that technology matches the job they need to perform but also on how well it helps to achieve the organization objectives.

Ammenwerth et. al [19] proposed a FITT framework which illustrate the importance of fit between user, task and technology. However, this framework does not utilize any existing technology acceptance models (as discussed in section 2.5) to provide theoretical supports to understand user acceptance issues. Furthermore, as mentioned by Ammenwerth et. al, this framework needs to be refined and balanced with other adoption theories. Although the organization aspects have been incorporated together with individual aspects and task aspects, this thesis believe that organization fit needs to be consider as one of the important factor together with user and technology which plays significant role user acceptance factor. For example, studies by [113, 193] show that the organization plays an important role in creating a positive effect on the user's attitude toward a technology, by providing encouragement and the right facilities to support the use of the technology.

Therefore, to understand user acceptance issues, it is important to understand not only how well user and technology 'fit' together but also how well they 'fit' with the organization. Integrating the TTF model with person-organization fit, could provide better understanding on user acceptance. The organization 'fit' with the user and technology, acts as a core determinant to the factors that influence a user's intention to use technology in addition to a task-technology fit. This thesis hypothesizes perceived user-technology-organization fit (PUTOF) as a core determinant of those factors which influence user intention to use technology.

3.5 Proposed Hypotheses Between PUTOF and UTAUT

The UTAUT model comprises of 4 core determinants of intention and usage; performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating condition (FC) [34]. Performance expectancy (PE) is defined as *"the degree to which an individual believes that using technology will increase his or her job performance"* [34]. According to Chau and Hu [194], physicians would be more likely to consider technology as being useful if they regarded it as being compatible with their present health care practices. This indicates that the higher the level of perceived fit between user and technology, the higher the utilization of the technology which also means the greater the job performance by the user. Thus, the following hypothesis is proposed:

- H_{1a}: PUTOF will positively affect PE.

Effort expectancy (EE) is defined as *"the degree of ease of use associated with the use of the technology or software"* [34]. An individual will choose to continue to use the technology if they perceive that the technology is easy to use and helpful [53]. According to Short et. al [195], the reluctance of health care professionals to use systems occurs because of their limitation in IT skills. The perception formed is that the skills or knowledge that a user has will affect their belief on how easy the technology is. The greater the belief that they have the necessary skills and knowledge to use the technology, the greater the likelihood that they will find the technology easy to use. Therefore, this thesis proposed the following hypothesis:

- H_{1b}: PUTOF will positively affect EE.

Social Influence (SI) is defined as *"the degree to which an individual perception of social normative pressure or relevant others believe that he or she should perform such behavior"* [34]. The social influence effect on intention to use technology has been shown to be significant in various acceptance studies [34, 54, 196]. However, in some studies it has been shown to have no significant effect on intention to use [15,78,79]. If users believe that their colleagues will support the use of a new technology or software, it will most likely influence their acceptance of the technology. This thesis examined whether PUTOF could affect the social influence factor. Thus, the following hypothesis is proposed:

- H_{1c}: PUTOF will positively affect SI.

Facilitating condition (FC) is defined as *"the degree to which an individual believes or perceives that a satisfactory level of infrastructure exists to support the use of the software"* [34]. Management is responsible not only to provide technology to enhance organization functions and services, but also to make sure that the introduction of this technology is compatible with the current setting of the organization. According to Wu et. al [9], in order to facilitate effective mobile health-care it is essential for the management to understand what practitioners need and also to improve their technical skills with well-matched resources. The influence of PUTOF will be increased when a user believes that appropriate facilities exist to allow them to use the technology effectively. Therefore, the following hypothesis is proposed,

- H_{1d}: PUTOF will positively affect FC.

3.6 Proposed Hypotheses Between PUTOF and IS Success Model

The DeLeon McLean IS Success Model consists of several constructs, including system quality, information quality and service quality. These three constructs served as a determinant of intention to use and user satisfaction [35]. The IS Success Model defines system quality as one of the determinants of intention to use. Since this thesis empirically tested the theoretical proposed model with students intention to use medically related software, this thesis uses software quality instead of system quality (to be specific to the context of study). However, the definition and the measurement items to measure this construct closely follow the original 'system quality' construct [187, 197].

According to Seddon and Kiew [133] *"system quality (SWQ) is concerned whether or not there are bugs in the system, the consistency of user interface, ease of use, response rates in interactive systems, documentation, and sometimes, quality and maintainability of the program code"*. This study defined System Quality (SWQ) as 'a concern with whether or not there are bugs in the system, the consistency of user interface and the response rate of the software perceived by the user'. The importance of system or software quality is measured through an overall use of that particular system which will be dependent on a systems overall performance [82]. If a user perceives that the software has lots of bugs, for example, it will result in a low perception of the fit between them and the software. This is aligned with what is suggested by Goodhue [84] who found that users evaluate the quality of a system and decide to use it if they perceive the system matches the task it needs to perform. Thus, the following hypothesis is proposed:

- H_{2a}: PUTOF will positively affect SWQ.

Seddon and Kiew [133] defined Information Quality as *"a concerned with such issues as the timeliness, accuracy, relevance, and format of information generated by an information system"*. This thesis defined Information Quality (IQ) as 'the degree to which information produced by the software has the attributes of content, accuracy, and format perceived by the users'. If a user perceives that the software produces the required information to do their job, then they will use that particular software. This is a result of the perception the user has between them and the quality of information provided by the technology; technology which is introduced by the organization. Thus, user perception on the existence of 'fit' will have an impact on the construct 'information quality'. Thus, the following hypothesis is proposed:

- H_{2b}: PUTOF will positively affect IQ.

Delone and McLean [13] defined Service Quality (SERQ) as *"overall support delivered by the service provider, applies regardless of whether this support is delivered by the IS department, a new organizational unit, or outsourced to an Internet service provider (ISP)"*. This thesis defined Service Quality as 'support delivered by the service provider to the organization'. This is measured by four indicators, which are, reliability, responsiveness, assurance and empathy [198]. If the user forms a belief that the developers or technical support are available to assist them with the use of the technology, it will increase their perception of service quality, which influences their intention to use the system. The influence of all these constructs on intention to use are dependent on the existence of 'fit' between user, technology and organization. Without this perception ('fit'), even a good system or software may not be successfully implemented in the organization. Thus, the following hypotheses are proposed:

- H_{2c}: PUTOF will positively affect SERQ.

3.7 Proposed Hypotheses Between PUTOF, MS and ISE

In addition to the constructs defined by both UTAUT and the IS Success Model, two new constructs are proposed which this study believes could predict intention to use technology. Further, these two constructs are proposed as dependent on perceived fit between user, technology and organization. These constructs are Information Security Expectancy(ISE) and Management Support(MS).

A number of studies have addressed security issues surrounding implementation of technology [67,120,199–206]. Development of the latest technologies is a challenge with respect to the security of the information provided by the technology including health care related technology. Among many issues of information security, access is complex due to the different levels required by different users such as GPs, doctors, nurses and administrative personnel [26, 121]. Information security is a major concern among health care professionals because it involves privacy of patients' sensitive information [207]. It needs to be addressed as an important factor that could influence user adoption of particular technology, especially within the health-care industry [27, 208].

According to Ferreira et. al , Information Security has three properties; confidentiality, integrity and availability (CIA), defined as follows [120]:

- Confidentiality is *"the prevention of an unauthorized disclosure of information"*,
- Integrity is *"the prevention of unauthorized modification of information"*,
- Availability is *"the prevention of unauthorized withholding of information or resources (CIA)"*.

In this thesis, ISE is defined as 'the degree to which an individual believes or perceives that sensitive information is not viewed, stored or manipulated by an unauthorized person'. Above three properties are defined for ISE construct which are confidentiality, integrity and availability. The organization needs to ensure that the introduction of new technology provides the necessary information security features.

A study by Lu et. al. [115] shows that one of the barriers for the adoption of personal digital assistance (PDAs) among health care practitioners is the issue of security particularly data encryption. As users become more aware of information security, the more they perceive that using the particular technology or software is safe in terms of security of information provided by the technology. Further, a study by Ayatollahi et. al. [119] shows that emergency staff were not confident on the confidentiality of the information in the system and unsure whether they would use the system in the future. This clearly indicates the importance of fit between user and systems introduced by the management. If users perceive a low fit in terms of security of information provided by the systems with the task the user needs to perform, it would increase the chance of the system being ‘rejected’ by the users. When the user perceives that a particular software provides all the necessary security features on, for example, protection of patient records, it would increase their intention to use the software. This is a result of the belief that the user has on the technology they use which is provided by the organization. Thus, the following hypothesis is proposed:

- H_{3a}: PUTOF will positively affect ISE.

If the user believes that the organization provides the right software which provides protection of sensitive data, then it will increase acceptance of the software and indicates that there exists a ‘fit’ between user, technology and organization. The greater the perception of fit between user and technology, the greater the perception on information security features. And the greater the information security expectancy, the greater the intention to use the software. Thus, the following hypotheses are proposed:

- H_{3b}: ISE is positively associated with Intention to Use (ITU).;

Management support in this thesis is defined as ‘the degree of supportive working environments and encouragement provided by the management to innovate and improve working practice’. Management support for a project where information system success is largely dependent on user involvement is critical according to Guimaraes et. al. [209]. The management is responsible for influencing, coordinating and directing peoples’ activities in order to achieve the organization’s goal and objectives. Various publications have highlighted the importance of management to provide a supportive environment where users are working and also encouragement, which could improve their working practice [23, 25, 65, 195, 210]. Providing the necessary resources for effective use of the information system would develop interest in users' satisfaction towards the system introduced by the management.

As stated by Randell and Dowding [23], many of the nurses in their study mentioned the supportive nature of the environment where they worked and valued the encouragement given to them by NHS managers to innovate and improve their practice. Having a positive working environment and management support will increase the likelihood of acceptance of new technology, therefore management support is important. Management support needs to be part of the organizational's culture. It is believed to have a strong influence on user behavior in carrying out daily tasks [189]. Further support can be found in a study by Mahmood et. al [211]. The study synthesized and validated nine constructs of IT end-user satisfaction using a meta-analysis and found organizational support to have the most significant relationship with end-user satisfaction [211]. A study by Lu et. al [115] shows that one of the barriers for the adoption of personal digital assistance (PDAs) among health care practitioners is the lack of institutional support. This work provides further support for the proposed management support construct in this thesis. Thus, the following hypothesis is proposed:

- H_{3c}: PUTOF will positively affect MS.

Users' positive attitudes towards computers have been found to be a likely indicator of software acceptance as well as strong support for a dependency between attitudes and satisfaction [212]. Further, a study by Davis [12] shows that user acceptance of a technology could be predicted through measuring their intention to use the technology. Lee et. al. [102] found that the attitude of a user would affect system utilisation, therefore influencing these attitudes will have an effect on utilisation. Management needs to influence user attitudes towards acceptance of new technology to increase user utilisation of the technology. When a user perceives that management support is available, the higher is the chance of the user accepting the system. Thus, the following hypotheses are proposed:

- H_{3d}: MS is directly and positively associated with Intention to Use (ITU).;

3.8 Summary

As discussed in previous chapters, one of the objective of this thesis is to investigate the role of perceived fit between user, technology and organization as a determinant of those factors associated with user acceptance of technology as well as to provide deeper understanding of the development of the proposed theoretical model which are examined within the health-care domain. In order to achieve this objective, the theoretical model investigate the relationships between perceived user-technology-organization fit with those factors defined by both the UTAUT Model and the IS Success Model in a single framework.

11 hypotheses , H_{1a}, H_{1b}, H_{1c}, H_{1d}, H_{2a}, H_{2b}, H_{2c}, H_{3a}, H_{3b}, H_{3c}, H_{3d}, have been formulated to contemplate the causal relationships between the underlying constructs. The perceived user-technology-organization fit (PUTOF) construct is known as an exogenous construct and the remaining constructs are known as endogenous constructs. As identified in the literature (section 2.9, section 2.10) and phases of the study (section 3.2), two new constructs which are Information Security Expectancy (ISE) and Management Support(MS) are integrated into the proposed model, as these constructs are being acknowledge as playing important role in influencing user acceptance of technology. These two constructs also permits the proposed theoretical model to fill the gap in user acceptance studies, by suggesting the link between PUTOF with ISE and between PUTOF with MS (H_{3a}, H_{3b} respectively). Further, the link between ISE with ITU (H_{3c}) and between MS with ITU are also incorporated (H_{3d}) and examined in this thesis. The following chapter, Chapter 4 discuss the methodology adopted in order to test the proposed 11 hypotheses in this research.

Chapter 4

Research Methodology to Examine The Proposed Model of User Acceptance

4.1 Introduction

The previous chapter has discussed the theoretical model which is empirically tested in this thesis. Chapter 4 presents the methodology used to examine the proposed theoretical model in this thesis. Following the introduction section, Section 4.2 discusses the research method employed and justifies the choice of a mixed methodology. Section 4.3 describes the measurement scale items for each underlying constructs proposed in the theoretical model. Section 4.4 discusses the instrument used to collect the data followed by Section 4.5 which describes the instrument evaluation through pilot test, prior to the final survey. The final survey is presented in Section 4.6 which discuss the procedures used to collect the data. This is followed by Section 4.7 which explains and justifies the statistical techniques used which is the Partial least Squares (PLS) approach to structural equation modeling (SEM). Section 4.8 describes the software used for data analysis. Section 4.9 discusses the two-stage approach used to conduct the analysis, followed by issues on the reliability and the validity of the measurement instrument. Assessments involved in each stage are discussed in Section 4.10 and Section 4.11. Section 4.12 present the ethical considerations in this research. Finally Section 4.13 concludes the chapter.

4.2 Research Method

This section provides an overview of the research method used to answer the research questions identified in **Chapter 1**. In order to examine the proposed model and hypotheses proposed in **Chapter 3**, a survey methodology using a self-administered questionnaire was used for collecting data from the sample of medical students in various medical schools within United Kingdom. Within evaluation research in the health informatics domain, two main traditions can be adopted which are the objectivist tradition (also known as positivistic or quantitative) and the subjectivist tradition (also known as interpretative or qualitative) [1]. As stated by Kaplan et. al. [213], *"quantitative approach seem useful when a theory is already established and also when individual relationships should be quantified and validated"*. In this thesis, the proposed theoretical model is based on existing technology acceptance models with an addition of three constructs which are perceived user-technology-organization fit, management support and information security expectancy. The relationship between the existing model with new proposed constructs will be examined and validated. Thus, an objectivist approach is deemed suitable and is adopted in this thesis to examine the proposed hypotheses.

This study does, however employ a small section of the subjectivist or qualitative method where an open-ended questions were included within the survey instrument. By combining both quantitative and qualitative methods, data obtained could provide a richer and contextual basis for interpretation and validation of the results [132, 213], therefore it is an important methodological consideration. Further, integrating both traditions will help to get comprehensive answers to the research questions [136,214]. Within the context of this thesis, adding open-ended questions in the questionnaire can lead to the discovery of factors not considered during the development of the questionnaire [214]. As stated by Chiasson et. al [43], *"the variety of human, contextual and cultural factors that affect system acceptance in actual use would not have been identifiable through quantitative methods alone"*.

Ammenwerth et. al [214] pointed out that although when a research is strongly based on the quantitative method, by combining it with qualitative method it could provide a mean to, for example, identify variables that can be quantifiable and help explain quantitative findings. Nevertheless, as one of the objectives of this thesis is to investigate the causal linkage between the underlying variables defined in the model, the objectivist or quantitative approach was mainly employed in this thesis.

4.2.1 Survey-Based Research

The objective of the survey was to evaluate and validate the proposed theoretical model. This study emerged from investigating the role of perceived fit between the user, the technology and the organization fit (PUTOF) as a core determinant of factors that influence user intention to use technology. The target population chosen was medical students particularly in the United Kingdom. The sample was drawn from various medical schools in United Kingdom where medical students are studying. As described in Section 3.2, the study in this thesis began by investigating and understanding medical students' usage and intention to use the *Distiller* software. This laid the foundations for the first step in the development of the proposed theoretical model. Consequently, it was decided to empirically test the proposed theoretical model within the population of medical students. The sampling method adopted in the thesis could be classified as simple random sampling where all medical students in the various medical schools had an equal chance of being selected i.e. has the same opportunity to answer the survey because the email was send to all medical students in the mailing list to participate in the survey.

In order to reach a wide sample of respondents, a self-administered survey was considered to be the appropriate tool to collect data. Fricker and Schonlau [215] have listed both advantages and disadvantages of survey research. The advantages include access to unique or large populations, saving in both time and cost and ease of administering and recording questions and answers [215, 216]. The disadvantages, however, include lack of control on the time, determining whether the respondents are being truthful and also lack of details information due to no interviewer intervention available for explanation [36, 217].

Previous studies on technology acceptance in health-care have also adopted a survey-based method [9, 68, 71] to empirically test models. The reasons indicated above provide justification to use survey-based research in this thesis.

4.2.2 Self-Administered Survey

There are multiple ways of administering quantitative survey-based research including *self-administered*, *interview-completion*, and *observation* [36, 217]. Within the administered survey, there are various kind such as mail surveys, Internet survey and drop-off / pick up [217]. Most self-administered surveys use a structured questionnaire which uses a predetermined set of questions [217]. This allows the respondent to read the survey questions and record responses without the presence of an interviewer. The structured survey can be paper-based or computer-based.

This thesis uses a computer-based, structured survey delivered via the Internet, known as an Internet Survey [217]. Internet delivered surveys are usually placed on a specified website and the respondent is contacted separately by letter or email and is given the website location together with a unique password in order to access the survey. The respondents complete the survey and return it by clicking a send button. This method has advantages such as the possibility to reach large populations and no interviewer-related costs such as compensation, training, travel or search cost [217]. Another type of survey which is also used in this study is called the drop-off survey which is one kind of self-administered survey [218]. Drop-off method involves the researcher or representative of the researcher to travel to the respondent's location and hand-delivering survey questionnaires to respondents [218]. Once the survey is completed it will be collected by the representative or the researcher. Two advantages of this type of survey are, first, the availability of a person to answer any questions raised and second, the ability to generate interest in completion of the questionnaire (i.e through informal interaction with the respondents).

In the context of this thesis, the survey was developed using Smart-Survey which is an online survey software. Once the questionnaire was developed, the author browsed through the Internet to obtain list of medical schools. The medical council website listed 32 medical schools in alphabetical order. Each of these medical schools was examined in order to compile the email list of school's representative. Once the list has been compiled, the link to the questionnaire was then emailed to the medical schools' representative requesting the link to be posted to the medical students' emailing address, both undergraduate and postgraduate students. Smart-Survey does not require respondents to use a unique password. Once completed and submitted, questionnaire responses were saved in the provider server i.e. Smart-Survey server. The data is available on-line to be downloaded at anytime.

4.3 Measurement Scale Development

The constructs defined in the model were operationalized by selecting measurement scale items and scale type [219]. There were 11 constructs defined in the proposed theoretical model which are perceived user-technology-organization fit (PUTOF), effort expectancy (EE), performance expectancy (EE), social influence (SI), facilitating condition (FC), software quality (SWQ), service quality (SERQ), information quality (IQ), management support (MS), information security expectancy (ISE) and intention to use (ITU). All the measurement items for these constructs have been selected from published literature and relate to measures of user intention to use the technology. Measurement scales were selected for their validity and reliability. The wording of some measurement items was amended to suit the context of study (medically related software) as well as the sample (medical students). As pointed by Churchill [220], *"the researcher probably would want to include items with slightly different shades of meaning because the original list will be refined to produce the final measures"*. The modified measurement items were validated by conducting a short pilot study (described in Section 4.4). In total 43 measurement scale items were used to measure the underlying constructs in the proposed model.

Table 4.1 and Table 4.2 show the proposed constructs, modified measurement items for each construct and its references. The measurement items for constructs from the UTAUT model are primarily adopted from Venkatesh [34] and some other studies which have conducted both validity and reliability properties of the measured items, shown in the table below. Performance expectancy scales were basically adapted from [33, 34, 70, 78, 96]; Effort expectancy were adapted from [34, 70, 93, 221, 222]; Social Influence were adapted from [34, 70, 78, 221]; facilitating condition scale were adopted from [34, 70, 78, 96, 223]; items to measure construct from the DeLone McLean IS Success Model primarily adopted from [13]. System/Software Quality scales were adapted from [13, 29, 59, 81, 133]; service quality were adapted from [13, 81]; information quality scales were adapted from [13, 29, 59, 81, 133, 224]; items to measure new construct were adopted from various related studies. Information security expectancy were adapted from [187, 221, 224, 225]; management support scales were adapted from [114, 226]; items to measure behavioral intention were adapted from [34, 70, 71, 77, 78, 93, 223]; items to measure perceived user-technology-organization fit were adapted from various studies [14, 19, 85, 93–96, 100, 227].

All the constructs have been operationalized using the 5- point Likert scales, ranging from (1=strongly disagree) to (5=Strongly Agree). Likert-Scales were adopted because they are easy and does not take much time to answer by the respondents [36]. The study by Dawes [228] shows that 5- point and 7- point scales produce the same mean score as each other, once rescaled. Studies on user acceptance issues have used 5-point likert scales [18, 60]. Dawes [228] further suggests that indicators of customer sentiment such as satisfaction surveys may be partially dependent on the choice of scale format. Since, this thesis intends to measure user intention to use technology, the 5-point likert scale is deemed sufficient.

Constructs	Measurement Statement	Sources
Performance Expectancy (PE)		
PE-1	I believe by using medically related software it would improve my effectiveness on the job in the healthcare practice	[33,34,70,78,96]
PE-2	By using medically related software, I believe related tasks would be done more quickly.	
PE-3	Using medically related software would improve my job performance in the health care practice.	
PE-4	I believe by using medically related software it would enhance my productivity towards providing quality services to the public.	
Effort Expectancy (EE)		
EE-1	I believe if medically related software is user-friendly, I would easy for me to use it.	[34, 70, 93, 221, 222]
EE-2	I believe it would be relatively easy to retrieve records using medically related software.	
EE-3	I believe medically related software would be easy to use and be helpful to the doctors, nurses and other clinicians in providing care to patients.	
EE-4	I estimate it would be easy for me to become skillful at using medically related software in my healthcare practice.	
Social Influence (SI)		
SI-1	I use the software because departmental co-workers also use it.	[34,70,78,221]
SI-2	People who influence my behavior think I should use the software.	
SI-3	People who are important to me think that I should use the software.	
Facilitating Condition (FC)		
FC-1	I believe it is important that internal technical assistances are available to solve problems related to the software.	[34, 70, 78, 96, 223]
FC-2	It is important that necessary resources are provided by the management to be able the user to use the medical software.	
FC-3	It is important that organization provides training and documentation which is specific to the job role of the user.	
Software Quality (SWQ)		
SWQ-1	I believe medically related software would provide all the necessary functions to perform my intended tasks related to healthcare practice.	[13, 29, 59, 81, 133]
SWQ-2	I believe medically related software would be easy to use, flexible and provides benefits to my health care practice.	
SWQ-3	It is important that medically related software's response time or speed meets the requirement of the health care practice.	
SWQ-4	It is important that medically related software provides up-to-date information which is available 24/7 or whenever service is needed.	
Service Quality (SERQ)		
SERQ-1	I believe medically related software providers' supports are important to be available at all the time to solve problems related to software malfunction(empathy)	[13,81]
SERQ-2	When there is a problem with medically related software, I believe it is important that service provider solves the problem at reasonable time period (reliability)	
SERQ-3	Medically related software provider need to be willing to help and give prompt services to user (responsiveness).	
SERQ-4	I believe that medically related software provider need to have knowledge to do their job well (assurance).	
Information Quality (IQ)		
IQ-1	It is important that outputs produced by medically related software are clear, precise, readable and consistent.	[13, 29, 59, 81, 133]
IQ-2	I believe that outputs provided by medically related software would be sufficient to enable me to do required tasks.	
IQ-3	It is important that medically related software provides output in understandable format.	

Table 4.1: Measurement items for each of the construct and associated literatures

Constructs	Measurement Statement	Sources
Information Security Expectancy (ISE)		
ISE-1	I believe data confidentiality, data integrity and data availability are important features of any clinical related software.	[187, 221, 224, 225]
ISE-2	It is important the software provides features that prevent unauthorized or disclosure of information to protect data confidentiality or privacy issues.	
ISE-3	It is important that the software provides features which prevent or reduce users' error e.g. preventing medication error.	
ISE-4	It is important that the software provides features which prevent unauthorized modification of information to protect data integrity.	
Management Support (MS)		
MS-1	I believe it is important that management provides a supportive working environment such as pleasant work place, sufficient work space, sufficient numbers of computers etc.	[114, 226]
MS-2	It is important that management allows a reasonable transition period from previous medically related software to current software.	
MS-3	It is important that introduction of new medically related software is communicated to the user of the software.	
MS-4	I believe it is important that management provides encouragement to innovate and improve working practice through the use of medically related software.	
Intention To Use (ITU)		
ITU-1	Given an opportunity, I will use the software in my health care practice.	[34, 70, 71, 77, 78, 93, 223]
ITU-2	I intend to use medically related software in my practice as frequent as possible.	
ITU-3	I believe using medically related software would improve my health care practice.	
ITU-4	I estimate there would be high chance of me using medically related software in my health care practice.	
Perceived User-Tech-Org Fit (PUTOF)		
PUTOF-1	I believe it is important that the skills and knowledge I have fit with the medically related software introduced by the organization.	[14, 19, 85, 93–96, 100, 227]
PUTOF-2	I believe it is important that management provides medically related software that fit the way I work which allow for convenient and easy access to the data.	
PUTOF-3	It is important that management ensures that medically related software is fit or compatible with existing setting or architectures of the current software in the organization.	
PUTOF-4	I believe it is important that management provides medically related software which fit my expectation on software features such as secure, fast and reliable information and services at all time.	
PUTOF-5	I believe it is important that management provides technical assistance when I having trouble finding or using data.	
PUTOF-6	I believe it is important that management provides necessary support such as training, encouragement etc, which could influence me to use the medically related software.	

Table 4.2: Measurement items for each of the construct and associated literatures (Part 2)

4.3.1 Sample of Study

Respondents in this thesis are medical students studying medical related subjects in various universities situated in the United Kingdom. The original proposed population were medical practitioners, such as doctors, nurses, pharmacist etc. However an initial email shot to recruit participants from this population resulted in almost no responses. Practitioners have busy schedules, so despite a three month of response period (July 2010 - September 2010) and follow up email, there were insufficient responses and the feasibility of the target population taking part was re-evaluated. Medical students were chosen as the substitute population because they are more accessible than clinicians. They will be the people using any future medical technology consequently it is essential to understand their motivations i.e. if future technology is to be adopted. Rather than measuring actual usage of the software, this thesis shifted to measure intention to use. Various studies have shown that intention to use will subsequently influence actual usage [70, 79, 229]. By using 5- point Likert Scale, the respondents would rate the influence of each measurement items related to each underlying construct on their intention to use medically related software.

4.4 Measurement Instrument - Questionnaire

In survey-based research, a questionnaire is designed to gather empirical data from the sample. In this thesis, the measurement instruments was developed into 4 sections (see Appendix B). As mentioned in Section 4.2.2, this thesis adopted two approaches for reaching the sample which were an Internet survey and a Drop-off survey. The Internet survey was developed using features provided by the Smart Survey. The survey started with a front page which invite the respondent to participate in the survey and stated the objectives of the research together with eligibility requirements. Further, confidentiality, anonymity and contact details of the researcher were also highlighted. An indication of how much time needed to answer the survey was given. Language used was also kept simple to aid understanding and encourage completion.

The drop-off survey used a printed questionnaire, designed using suggestions given in the literature [230]. Suggestions include use of space between questions, font-size 10-12, font that is easy to read, avoiding italics, use of bold, underlining or capitals for emphasis and instructions etc. The end instrument had 8 pages. This printed questionnaire started with a cover page, invitation to participate in the survey, similar to the on-line survey. The details of each of these sections in the questionnaire are as follows:

- Section One: The first part of instrument consisted of 11 questions on gender, age, year of study, university, school, country, previous use of medical software and the name of the software used.

- Section Two: This section included 43 questions beginning with definitions of each constructs. All the constructs utilized a 5- point Likert type scale which range from strongly agree to strongly disagree. In order to get responses for all the questions related to measurement items, this section was mandatory. A pop-up box reminded respondents to provide answers for any question not answered.

- Section Three: This section consisted of general questions on the fit between user-technology-organization. One open-ended question was included where respondents were asked to indicate their opinion on factors influencing their intention to use medically related software. The objective of the open-ended question was to identify and compare the factors stated by the respondents, with the constructs defined in the proposed theoretical model.

In order to minimize the problem of common method variance [231], the questions in section two were mixed between measurement items measuring its associated constructs. For example question 14.2 in the questionnaire was related to software quality construct and 14.3 was related to information security expectancy construct.

4.5 Instrument Evaluation

Prior to the main survey, the instrument was evaluated to achieve the following objectives [232, 233]:

- To check that the questions are understandable.
- To assess the likely response rate and effectiveness of the follow-up procedures.
- To evaluate the reliability and validity of the instrument.
- To ensure that data analysis techniques match the expected responses.

According to Kitchenham and Pfleeger [232], there are two common approaches to evaluation research instrument; focus groups and pilot studies (pre-test). The purpose of the pilot study is to determine if there is any problems with the questionnaire, to ensure word clarity, understandability, to estimate time required to complete the questionnaire and to address any comments or suggestions respondents have. The pilot study involves distributing a draft of the questionnaire to a selected random sample of medical students. The pilot study was conducted by first obtaining verbal approval from the member of staff at the entrance desk of the library and then distributing the questionnaires to the medical students in the Greenfield Medical Library at Queens Medical Center (QMC), Nottingham in November 2010. A total of five medical students agreed to fill-up the questionnaire. Their comments and suggestions given were summarized in the Table 4.3 below.

Respondent	Comments and Suggestions
1	“make the instruction in cover page shorter”
	“please reduce the questions..so many!! ”
2	“ shorter version of survey”
3	“ page number??”
	“ some sentences are quite long”
4	no comments
5	“ easy to follow, understand the questions
	asked although some can make it simpler

Table 4.3: Respondents’ Comments and Suggestions During the Pilot Study

4.6 Final Survey and Procedures

The questionnaire was edited in response to the comments and suggestions from pilot study as follows:

a The original instruction in the cover page was a bit lengthy and it was edited to a shorter but clearer instruction without losing the important information.

b Several questions were deleted, however the questionnaire was checked to ensure that each construct was measured by a minimum of three measurement statements [219].

c In the original questionnaire, page numbers were not included and in the edited questionnaire, page numbers were.

d Some of the measurement statement were rephrased to make them shorter and more precise, without losing meaning.

The final survey was administered on December 2010 for a period of 6 months. A letter of formal invitation together with the Smart Survey web link to the questionnaire was emailed to representatives of various medical schools across United Kingdom, requesting their assistance to distribute the link using their mailing lists of medical students. In order to maximize the response rate, the researcher adopted simple random sampling as follows:

i Printed questionnaires were distributed among medical students in Nottingham University which resulted in 11 respondents. The students were first asked if they are medical students and then if they would like to participate in the survey. Only those who were medical students and agreed to participate were given the questionnaire.

ii The researcher contacted several personal contact medical students in Leicester University who agreed to help in distributing the questionnaire to other medical students in their University. On 18th of March 2011, the researcher met the students and distributed the printed questionnaire. It was emphasized to the students that the participant must be a medical student and the questionnaire needed to be distributed among all years of study and if possible to postgraduate students as well. Two weeks after the first meeting, the questionnaires were collected back on 1st April 2011 resulted in a further 14 respondents.

iii The researcher approached students at Greenfield Medical Library in Queens Medical Center (QMC), Nottingham. Prior to approaching the students, verbal approval was obtained from a member of library staff to distribute the questionnaire. Once this permission was obtained, students were approached and invited to complete the online survey. At this point, a check was carried out to ensure that the participants were medical students. This approach was carried out twice. In the first round, nine students agreed to take part (14th April 2011), and the second round (16th May 2011) resulted in five respondents. Each student took approximately 7-9 minutes to fill-in the questionnaire.

The data collected from the **drop-off** approach above [ii] were entered into the online survey by the researcher. However, the data for the first approach [i] were manually entered into the raw data file once it was downloaded from the smart-survey server. For the **Internet Survey**, a follow-up email was sent to the medical school representatives. At the end of May 2011, a total of 102 responses had been collected on-line (with 11 responses entered manually into the data file, giving a total of 113). The survey and number of respondents is shown in Figure 4.1. This includes the responses from printed questionnaire. Appendix B shows the final measurement instrument employed in this thesis.

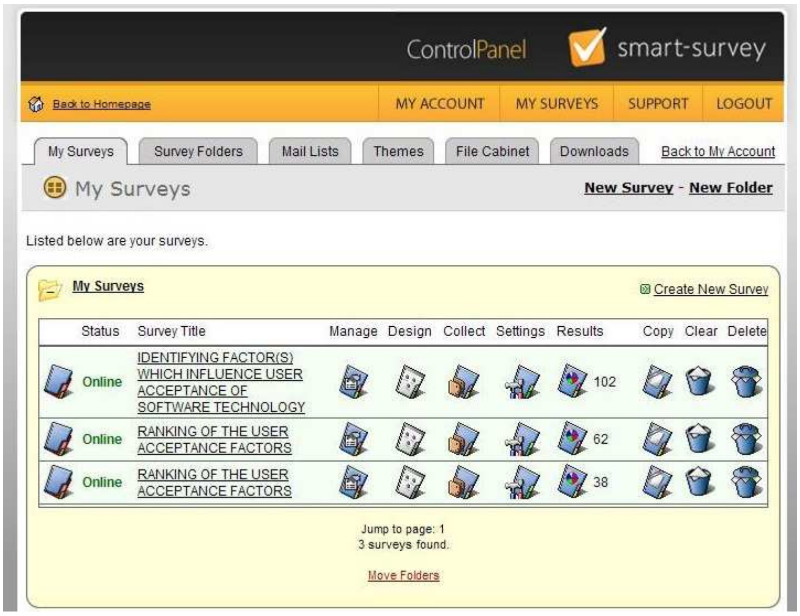


Figure 4.1: Screenshot showing responses to the survey

4.7 Data Analysis Method

PASW version 18 was used to analyze the preliminary data and the Partial Least Square (PLS) approach to Structural Equation Modeling (SEM) was used to test the hypothesized model.

4.7.1 Preliminary Data Analysis

To analyze the quantitative data resulted from the survey, this thesis, used PASW version 18 software. The software was used to identify outliers (i.e using Box and Whisker approach) and to obtain the mean and standard deviation for each of the measurement items. The values for mean and standard deviation were also provided by the WarpPLS version 3.0 software (software used in this thesis for data analysis). These results would provide preliminary information about the measurement items used in the questionnaire as well as information about the sample population.

4.7.2 Structural Equation Modeling (SEM)

There are various methods available to analyze the relationship between a set of variables including [219]:

- Discriminant Analysis (DA)
- Path Analysis (PA)
- Factor Analysis (FA)
- Multiple Regression Analysis (MRA)
- Structural Equation Modeling (SEM)

This thesis adopted Structural equation modeling (SEM). SEM is a second generation technique which can be used to explain the relationships between multiple variables [219]. Compared with first-generation techniques such as factor analysis, discriminant analysis etc, which examine only single relationships, SEM can simultaneously test and estimate causal relationships among multiple independent and dependent constructs [234].

SEM allows the researcher to construct unobservable latent variables (LVs) which cannot be directly measured. Latent variables (LVs) however are responsible to determine the correlation among the manifest variables. Observable and empirically measurable indicator variables known as manifest variables (MVs) were used to estimate LVs in the proposed model [219]. Indicators can be classified into two groups: (a) reflective indicators which depends on the construct and (b) formative which causes the formation of or changes in an unobservable variable [235]. Many studies have employed the SEM method to examine their hypothesized models [9, 29].

According to Anderson and Gerbing [37], SEM provides *"a comprehensive means for assessing and modifying theoretical models"*. SEM is more of a confirmatory technique but it also can be used for exploratory purposes. Confirmatory factor analysis (CFA) require one to specify which variables are associated with each construct. It involves testing, and potentially confirming a theory. CFA is a tool which enables the researcher to either 'confirm' or 'reject' pre-conceived theory.

As pointed out by Aibinu and Al-Lawati [224], first generation techniques such as factor analysis (FA), multiple regression analysis (MRA) and path analysis (PA) are not suitable as a method of analysis for the following reasons:

- MRA only handle the relationships between single dependent variables and many independent variables. Further, both MRA and PA only deal with manifest or observable variables and not with latent or unobservable variables.
- FA although could detect underlying latent variables from observed variables, it could not provide further information on the relationships between latent variables, for example, the relationship between perceived user-technology-organization fit (PUTOF) and performance expectancy (PE).

Further, SEM can simultaneously assess the measurement model (relationships between constructs and measures) and the path model (relationship between one construct and another) to test theoretical relationships.

There are two approaches to estimate the parameters of an SEM, namely, the covariance-based approach and variance-based approach (or component-based approach) [219, 235]. Covariance-based SEM attempts to minimize the differences in the sample covariances and those predicted by the theoretical model whereby the parameter estimation process try to reproduce the covariance matrix of the observed measures [219,235]. The variance-based approach on the other hand, focuses on maximizing the variance of the dependent variables explained by the independent ones [235]. The Partial Least Squares approach which is used in this thesis, is a variance-based SEM, described further in the next section.

4.7.3 Partial Least Square (PLS) Approach

Partial Least squares (PLS) is a variance-based approach also known as component-based approach used for testing structural equation models. It is also known as a soft modeling technique which does not require a normal distribution assumption [236]. According to Haenlein [235], PLS was first introduced by H. Wold in 1975 under the name NIPALS (nonlinear iterative partial least squares) which focuses on maximizing the variance of the dependent variable explained by the independent ones. PLS starts by calculating case values, unlike covariance-based SEM which estimates first model parameters and then case values. Thus, in PLS, the unobservable variables which is Latent variables (LVs) are measured as exact linear combinations of their empirical indicators [237].

As with SEM, PLS models also consist of two parts; a structural part, which shows the relationships between the latent variables, and a measurement part which shows the relationship between latent variables and their indicators. An additional features of PLS is weight relations which are used to estimate case values for the latent variables [238]. According to Urbach and Ahlemann [2], PLS can be used either for theory confirmation (confirmatory factor analysis) or theory development (exploratory factor analysis).

The following are the features of PLS [234, 238, 239]:

- PLS makes no distributional assumption. PLS avoid the assumptions that observations follows a specific distributional pattern and that they must be independently distributed.
- Relatively small sample size. A Monte Carlo simulation performed by Chien et. al. [240] indicated that PLS could be performed with a sample size as low as 50.
- Unlike covariance-based SEM, variance-based SEM yields robust results even in the presence of small samples and multivariate deviations from normality.

Urbach and Ahlemann [2] provided a detailed comparison between variance-based PLS and Covariance based SEM as shown in Table 4.4

Criteria	PLS	SEM
Objective	Prediction-oriented	Parameter-oriented
Approach	Variance-based	Covariance-based
Assumption	Predictor specification (non-parametric)	Typically multivariate normal distribution and independent observation (parametric)
Parameter estimates	Consistent as indicators and sample size increase	Consistent
Latent variable scores	Explicitly estimated	Indeterminate
Epistemic relationship between an LVs and its measures	Can be modeled in either formative and reflective mode	Typically only with reflective indicators. However, the formative mode is also supported.
Implications	Optimal for prediction accuracy	Optimal for parameter accuracy
Model complexity	Large complexity	Small to moderate complexity
Sample Size	Power analysis based on the portion of the model with the largest number of predictor. Minimal recommendation range from 30-100 cases.	Ideally based on power analysis of specific model - minimal recommendation range from 200 to 800
Type of Optimization	Locally iterative	Globally iterative
Significance tests	Only by means of simulations: restricted validity	Available
Availability of global Goodness of Fit (GoF)	Are currently being developed and discussed	Established GoF metric available

Table 4.4: Comparison between PLS and CBSEM Approaches (adapted from [2])

4.7.4 The Choice of PLS as a Method of Analysis

PLS is an alternative to component based SEM (CBSEM) [2]. This thesis adopted PLS-SEM method for the following reasons:

- **Phenomenon to be investigated is relatively new and measurement models need to be newly developed**. In this study, the phenomenon under investigation is a student's intention to use medically related software. Further, the proposed model integrates three existing models to provide one integrated model which is newly examined in this thesis. To the best of researcher's knowledge, no study has tested these integration models as a single model. Further, this thesis introduced three new constructs, perceived user-technology-organization fit, management support and information security expectancy (ISE) in the hypothesized model, hence it is a newly developed measurement model.

- **The structural model is complex with a large number of LVs and indicator variables**. In this thesis, the hypothesized model could be classified as a complex model with 11 latent variables which are measured with 43 indicator variables.

- **Relationship between indicators and LVs have to be modeled in different modes (i.e formative and reflective measurement model)**. In the proposed model, 10 of the constructs which are performance expectancy, effort expectancy, software quality, social influence, facilitating condition, service quality, information quality, management support, perceived user-technology-organization fit and information security expectancy are called reflective measures, in which the latent variables are posited as the common cause of the items or measured/ indicators variables. The intention to use (ITU) construct is a formative measure, in which the measured/ indicator variables is posited as the common cause of the latent variables. Since formative construct involves identification rules, the analysis of this type of construct using covariance-based SEM is quite difficult [241]. PLS on the other hand allows for the easy handling of formative constructs.

- **Estimation Assumption**. PLS-SEM, which is similar to the principal component analysis does not assume any form of distributional for the measured variables [239]. PLS is distributional-free which means it is suitable for data from non-normal or unknown distributions [236]. In this thesis, most of the measurement items, particularly PUTOF, IS, MS, (discussed in section 4.3) are perception-based and measured on a Likert scales. They are of unknown distribution, and since normality cannot be demonstrated, PLS-SEM was considered preferable to covariance-based SEM.

- **The condition relating to sample size is not met**. In order to use covariance-based SEM the minimal recommended responses are between 200 to 800 [219]. PLS estimates the model parameter using the original sample. PLS is suitable when the sample size is relatively small and when assumption on normality is uncertain. To use PLS-SEM it is suggested that the number of respondents needs to be ten times the number of items in the most complex constructs [234]. In the proposed model, PUTOF is measured by six items and requires a sample size of at least 60 in order to conduct the analysis. The number of respondents in this study was 113. The sample size does not met the requirement to use SEM however met the condition of PLS approach. Therefore, PLS is deemed suitable to analyze the data in this thesis.

- **Prediction more important than parameter estimation**. PLS path modeling is generally more suitable for studies in which the objective is prediction, the phenomenon under study is new or changing i.e the theoretical framework is not yet fully crystallized [241]. In the proposed theoretical model, with the introduction of perceived fit between user-technology and organization as well as the management support construct and information security construct, the hypothesized model is known as a predictive model, in which all new LVs were not previously tested in a single model together with constructs from the well established models, UTAUT and IS Success Model.

Based on the above criteria, this study adopts PLS as a suitable method to analyze the empirical data. The PLS method has been used in published studies [15, 70]. Further, the PLS technique has been used by Venkatesh et. al. [34] who developed the UTAUT Model to investigate technology acceptance. The UTAUT model is one of the models the proposed theoretical model, in this thesis, is based on.

4.7.5 Basic PLS-SEM Algorithm

According to Hair et. al. [242], the basic PLS-SEM follows a two-stage approach. In the first stage, the latent constructs' scores are estimated using a four-step process. This is shown in table 4.5. The second stage calculates the final estimates of the outer weights and loadings as well as the structural models' path coefficient. The path modeling is known as partial because the iterative PLS-SEM algorithm estimates the coefficients for the partial ordinary least squares regression models in both measurement model and structural model [242].

Stage One: Iterative estimation of latent construct scores
Step 1: Outer approximation of latent construct scores (the scores of for example PE, EE, SI etc are computed based on the manifest variables' scores and the outer coefficients from Step 4) Step 2: Estimation of proxies for structural model relationships between latent constructs (Y_1 and Y_2) Step 3: Inner approximation of latent construct scores (based on scores for PE, EE, and SI from Step 1 and proxies for structural model relationships, Y_1 and Y_2, from Step 2) Step 4: Estimation of proxies for coefficients in the measurement models (the relationships between indicator variables and latent constructs with scores from Step 3; W_1 to W_43)
Stage Two: Final estimates of coefficients (outer weights and loadings, structural model relationships) are determined using the ordinary least squares method for each partial regression in the PLS-SEM model

Table 4.5: Stages in Calculating the Basic PLS-SEM Algorithm

4.7.6 Path Diagram

The hypothesized relationships between latent variables can be represented in the form of a path diagram. Figure 4.2 shows the visual representation (path diagram) of a measurement theory. The path diagram in this thesis consists of constructs measured variables, measurement errors and also arrows which represent relationships between the variables. For example, the constructs perceived user-technology-organization fit (PUTOF), performance expectancy (PE), effort expectancy (EE), etc are presented as ovals (latent variables). Measured variables for each latent variables are presented in rectangle as X_1-X_{43}. For example, the 'performance expectancy' (PE) is measured by four measurement items. The link shown between PE with its associated measurement items (X_1, X_2, X_3, X_4) are

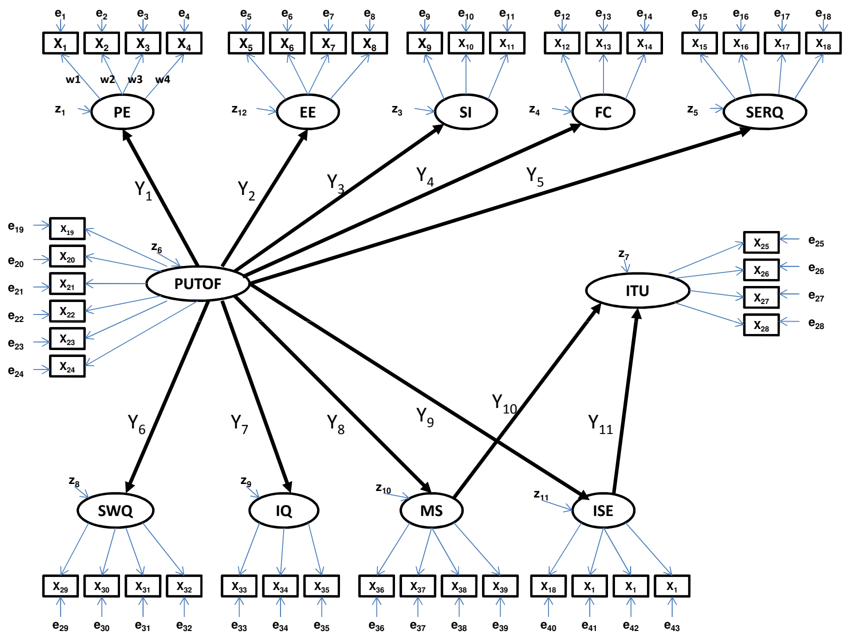


Figure 4.2: The Detailed Path Diagram of This Thesis (the ovals represent the latent variables and the rectangles represent the measured variables)

similar to factor loading in factor analysis. Further, the single-headed arrows in the diagram represent linear dependencies which indicate the dependency of one variable to another variables. For example, the arrow connecting PUTOF with PE represents a direct relationship that is hypothesized between these two variables. The path coefficients shown in the diagram as Y_1 - $Y_1 1$ are similar to the path coefficients in path analysis. Included are measurement errors associated with the composite variables which are represented as (e) and also residual errors associated with latent variables which are represented as (z).

4.8 Software Used for Analysis

WarpPLS is a nonlinear structural modeling analysis developed by Prof Ned Kock [243]. The first version of the software was released on 2009,a second version was released in 2011, followed by a third version which was released in 2012. This thesis used first WarpPLS 2.0 followed by WarpPLS 3.0 to explore statistical relationships among the measurement items of each construct and between the factors of independent (perceived user-technology-organization fit) and dependent variables (performance expectancy, effort expectancy, social influence, service quality, facilitating condition, software quality, information quality, management support, information security expectancy and intention to use) [244].

According to Kock [245], the vast majority of relationships between variables, in investigations of both natural and behavioral phenomena, are non-linear and usually take the form of U-shaped and S-shaped. SEM tools such as LISREL, EQS and AMOS, do not usually take non-linear relationships between LVs when calculating path coefficient, respective P-value or R^2 coefficient. On the other hand, WarpPLS software takes non-linear relationships into consideration when performing statistical analysis [245]. With WarpPLS, researchers present the model in a path diagram to show the proposed link among variables.

This thesis used Warp3 PLS Regression algorithm to analyze the data, which is the default algorithm used by the software. WarpPLS attempts to identify a relationship defined by a function whose first derivative is a U-shaped curve [245]. This type of relationship follows a pattern that similar to a combination of two connected U-shaped curves [245]. The empirical data can be tested against the hypothesized model for estimating path coefficient, calculating p-values, model fit indices and multicollinearity [244, 245].

4.9 Model Validation - Two-Stage Approaches

According to Urbach and Ahlemann [2], model validation is a process of *"systematically evaluating whether the hypotheses expressed by the structural model are supported by the data or not"*. Model validation is a process to determine if the measurement models and the structural model would fulfill the quality criteria of the empirical work. To carry out model validation process, this thesis adopted the two-stage approach recommended by Anderson and Gerbing [37]:

i **Stage One**: Focus on reliability and validity of item measured. These are the 2 main criteria used for testing the goodness of measures. Reliability of measurement items is tested on how consistent it measures the concepts it is measuring [36, 219, 233, 246]. Validity of the measurement items, on the other hand, is tested on how well it measures the particular concept it is intended to measure [36, 219, 233, 246].

ii **Stage Two**: Model evaluation or structural model is analyzed to test proposed research hypotheses. Predictive power is assessed by R^2 values of the endogenous constructs.

According to Hair et. al. [219], by conducting two stages analysis, researcher could ensure the reliability of the measurement items of each construct and avoid any interaction between the measurement and structural model. This means measurement model needs to be analyzed first on items reliability and validity prior to analyzing the relationships proposed in the structural model. Once the conditions of measurement model are satisfied, the second stage can be performed. The two-stage approach is adopted in this thesis. Using PLS, both measurement model and structural model are tested together. Further, as opposed to SEM which requires testing the unidimensionality property of the measurement items, using PLS, the loading of the measurement items (stage one) will be checked to determine whether any measurement items need to be deleted. Measurement items that load poorly on the hypothesized constructs can be removed from the scale. Published studies have adopted the two-stage approach in their analysis of the data [37, 224, 237, 241].

4.10 Stage One: Assessing the Measurement Model

In order to assess the measurement model, this thesis followed the validation guideline suggested by Chin [236], to test the measurement model for reliability and validity by applying standard decision rules. Both validity and reliability of measurement items need to be assessed to ensure the quality of the findings and conclusion of this thesis. The adequacy of the measurement model are assessed using the following criteria [2, 224]:

- Individual item reliability analysis.
- Convergent validity of the measurement instrument.
- Discriminant validity of the measurement instrument.

Figure 4.3 shows the the first stage of the analysis (measurement model) which is performed by specifying the causal link between the manifest variables (measurement items) and its underlying latent variables. The oval shows the latent variables while the triangular shows the measurement items for each of the latent variable.

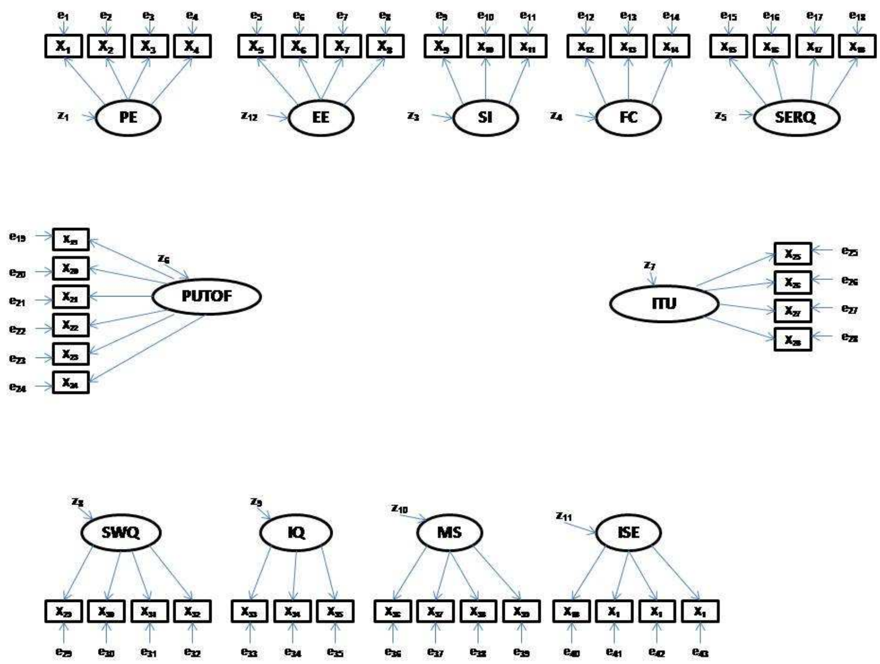


Figure 4.3: Measurement Model (the ovals represent the latent variables and rectangle represents the measured variables)

4.10.1 Assessing Individual Item Reliability

Assessment of reliability is conducted for reflective LV indicators. Kock [245] defines reliability as *"a measure of the quality of instrument.."*. This means that each question-statements associated with each latent variable are understood in the same way by different respondents. Reliability can be assured when a scale produces consistent results every time a repeated measurements are made on the variables of concern. Aibinu and Al-Lawati [224] defines individual item reliability as *"the extent to which measurement of LVs measured with multiple-item scale reflects mostly the true scores of the LVs relative to the error"*. In other words, individual item reliability can be assessed by looking at the standardized loadings of the measurement items with respect to their latent construct. According to Hulland [247] items with loadings of less than 0.40 or 0.50 should be dropped. Hair et. al. [219], recommend 0.50 be used as cutoff point for scales adapted from other settings and new scales. Since scales from various sources were adopted (as described in Section 4.3), this thesis followed the recommendation proposed by [219] and adopted 0.50 as a cutoff value.

4.10.2 Convergent Validity

Assessing reliability alone is not sufficient for an instrument to be adequate [37,219,248]. Validation of all the constructs defined in the proposed model is also required. Construct validity is concerned with what the measurement instrument is actually measuring. It refers to developing correct and adequate measures for the construct i.e concept being tested [248]. In this thesis, construct validity is examined by analyzing both convergent validity and discriminant validity.

Convergent validity is the measure of the internal consistency in which, multiple measurement items which measure the same construct (concepts) are in agreement [248]. Convergent validity is defined as *"the degree to which individual items reflecting a construct converge in comparison to items measuring different constructs"* [2]. It is used to ensure that the measurement items assumed to actually measure each latent variable and not another latent variable. In PLS-SEM method, the convergent validity of the measured constructs are assessed by measuring [219, 249] :

- Factor loadings
- Composite reliability scores (p_c)
- Average variance extracted (AVE)

The loading for all items are suggested to be 0.50 or more [219]. Composite reliability measures the internal consistency of the constructs. According to Urbach and Ahlemann [2], Cronbach alpha assumes that all indicators are equally reliable and this tends to underestimate the internal consistency reliability of LVs in PLS structural equation models. Composite reliability score is said to be superior to Cronbach's alpha measure of internal consistency because it uses the item loadings obtained within the theoretical model [249]. Nonetheless, as pointed by Aibinu and Al-Lawati [224], the interpretation for both composite reliability score and Cronbach's alpha is the same. Hair et. al. [219] recommends 0.70 as a cut-off point for composite reliability. The formula for calculating composite reliability score is [224]:

$$p_c = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + \sum_i var(\varepsilon_i)} \tag{4.1}$$

where p_c is the composite reliabilty score, λ_i is the component loading of each item to latent variable and $var(\varepsilon_i) = (1 - \lambda_i^2)$.

According to Urbach and Ahlemann [2], average variance extracted (AVE) is used to *"measures the amount of variance that a latent variable captures from its measurement items relative to the amount of variance due to measurement errors"*. AVE can be calculated as follows [249]:

$$AVE = \frac{\sum \lambda_i^2}{\sum \lambda_i^2 + \sum_i var(\varepsilon_i)} \tag{4.2}$$

where AVE is the average variance extracted, λ_i is the standardised loading for each observed variable, and $var(\varepsilon_i)$ = $(1 - \lambda_i^2)$.

The recommended value for AVE should be greater than 0.50 [2, 219], and this value was used as an indicator for supporting convergent validity. This value of 0.50 means that at least 50% of measurement variance is captured by the latent variable.

In this thesis, the value of loading, Cronbach's alpha, composite reliability, and AVE are all calculated simultaneously by WarpPLS software [245]. The following standard rules were used as cut-off values:

- Factor loading greater than 0.50, as recommended by [219]
- Composite Reliability (C.R) – 0.70 as recommended by [219]
- Cronbach's Aplha – 0.60 as recommended by [250]
- Average Variance Extracted greater than 0.50 as recommended by [2, 219]

4.10.3 Discriminant Validity

Discriminant validity is the degree to which the measurement items are not a reflection of other variables [248]. According to Kock [245], *"a measurement instrument has good discriminant validity if the question-statements associated with each LV are not confused by the respondents to the questionnaire with the question-statements associated with other LVs, particularly in terms of the meaning of the question-statements"*.

The property of discriminant validity can be examined by comparing the correlations between latent variables and the square root of average variance extracted (AVE) for a latent variable. The diagonal of the matrix contains the square roots of the AVEs which must be greater than off-diagonal elements in the corresponding row and columns (i.e correlation of two latent variables) to confirm with discriminant validity [219, 249]. This criteria is applied for both reflective and formative indicators.

4.10.4 Reliability Analysis

Cronbach's alpha is the measure of coefficient of reliability. It estimates the degree to which the items in the scale are representative of the domain of the single one-dimensional latent variable being measured [2, 219, 250, 251]. Cronbach's alpha value can be used to verify the reliability property of the composite items for each latent variable. Thus, each latent variable, performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating condition (FC), software quality (SWQ), service quality (SERQ), information quality (IQ), management support (MS), information security expectancy (ISE), and perceived user-technology-organization (PUTOF), defined in this thesis, are subject to such assessment. If a data suffer with a multidimensional structure, Cronbach's alpha usually show a low value. Cronbach's alpha can be calculated using formula given by Fornell and Larcker [249] as below:

$$p_\eta = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + \sum \varepsilon_i} \tag{4.3}$$

where λ_i is the standardized loading for each observed variable, ε_i is the error variance associated with each observed variable, and p_η is the measure of construct reliability.

In assessing the reliability through Cronbach alpha, Nunnally [250] suggests a rule of thumb level of higher than 0.70 with level as low as 0.60 being acceptable for new scale. It is generally agreed that an alpha value above 0.60 is acceptable [250].

4.10.5 Assessing Formative Construct - Intention to Use

In this thesis, intention to use is defined as a formative construct. The validation of formative measurement models requires a different approach than that for reflective measurement models. Henseler et. al. [252] suggest assessing the validity of formative constructs on two levels which are at the indicator level and construct level. At the construct levels, formative measures are assessed by checking discriminant validity [2]. At the indicator level, formative measures need to be assessed on indicator weights and variance inflation factors.

Urbach and Ahlemann [2] report that indicator weights of measurement items for formative construct needs to be at 0.050 significant level which suggests that an indicator is relevant for the construction of the formative index and demonstrate a sufficient level of validity. A variance inflation factor (VIF) is a measure of the degree of multicollinearity among the LVs that are hypothesized to affect another LV [245]. It is recommended that variance inflation factors lower than 5 [219, 245, 253].

In summary, both validity and reliability of the constructs are established prior to testing the underlying hypotheses. For this purpose, individual item reliability, convergent validity and discriminant validity of the variables are assessed first in stage one. Once the required conditions are fulfilled, the structural model is then assessed.

4.11 Stage Two: Assessing the Structural Model

After stage one is established, the next stage is to analyze the proposed structural model. As described in subsection 4.7.3, PLS analysis emphasis is on the variance explained and also the significance of all path estimates. The structural model is defined as *"a set of one or more dependence relationships linking the hypothesized model's constructs; representing the interrelationships of variables between constructs "* [219]. The structural model aims to specify which latent constructs directly or indirectly influence the values of other latent constructs in the model [254]. The structural model in PLS-SEM is assessed by examining the explanatory power of the structural model and the path coefficient. Thus, in this stage, several properties were assessed to provide support for the proposed theoretical model [2, 236] :

4.11.1 Coefficient of Determination, R^2

This is the first criterion for assessment of the PLS-SEM, where each endogenous LV's coefficient is measured, is by examine the coefficient of determination. According to Breiman and Friedman [255], the criterion R^2 is critical in evaluating a structural model, it measures the amount of variation of each endogenous construct accounted by the exogenous construct. Chin [256] considers values of around 0.670 as substantial, values around 0.333 as average and values of 0.190 and lower as weak.

4.11.2 Predictive Relevance, Q^2

According to Urbach and Ahlemann [2], the Q^2 statistics is a measure of the predictive relevance of a block of manifest variables. The structural model's predictive relevance can be assessed via nonparametric Stone-Geisser test [257, 258]. Q^2 values indicate how well observed values are reconstructed by the model and its parameter estimates. Positive Q^2 values confirm the model's predictive relevance in respect of the particular construct. Q^2 less than 0 mean that the model lacks predictive relevance. The proposed threshold value is $Q^2 > 0$ [2].

$$Stone - Geissertest, Q_j^2 = 1 - \frac{\sum_k E_{jk}}{\sum_k O_{jk}} \tag{4.4}$$

4.11.3 Effect Size, f^2

Effect size measures if an independent LV has a substantial impact on a dependent LV [259]. It is calculated as the increases in R^2 of the LV to which the path is connected, relative to the LV's proportion of unexplained variance. Values of between 0.020 and 0.150, between 0.150 and 0.350 and exceeding 0.350 indicate whether a predictor LVs (exogenous LV) has a small, medium or large effect on an endogenous LV respectively [234, 256]. The effect size was calculated using Cohen's f^2 formula as follows [259]:

$$f^2 = \frac{R_{incl}^2 - R_{excl}^2}{1 - R_{incl}^2} \tag{4.5}$$

4.11.4 Path Coefficient

Path coefficient between the models shows the algebraic sign and magnitude as well as significance [236]. The magnitude of path coefficient's shows the strength of the relationships between two latent variables. In this thesis, the path coefficient of perceived user-technology-organization fit (PUTOF) with performance expectancy (PE), PUTOF with effort expectancy (EE), PUTOF with social influence (SI), PUTOF with service quality (SERQ), PUTOF with software quality (SWQ), PUTOF with facilitating condition (FC), PUTOF with information quality (IQ), PUTOF with management support (MS), PUTOF with information security expectancy (ISE) as well as management support (MS) with intention to use and information security expectancy with intention to use were assessed to look at the the strength of the proposed relationships in the model.

As discussed in Section 4.7.3, PLS does not rest on any distributional assumptions. Therefore, information on the variability of the parameter estimates as well its significance has to be generated by means of resampling procedure. In order to determine the significance between LVs, three widely known re-sampling techniques can be used which are bootstrap, blindfolding and jackknife [236, 243]. Jackknife explores how a model is influenced by subsets of observations when outliers are present. Bootstrap resampling method which was invented in 1979 is believed to be able to draws more sub-samples compared to jackknife method [236]. However, compared to jackknife method, bootstrap method takes longer time in estimating standard error values because along with normal approximation, it also make use confidence interval procedure [236].

Blindfolding, on the other hand, tends to perform somewhere in between jackknifing and bootstrapping [243]. As stated in [243], in the case of sample sizes lower than 100, if the number of resamples is very close to this sample size and with the presence of outliers, the blindfolding method is said to perform similarly to the jackknifing method. On the other hand, when sample size is large and when all data points are distributed evenly on a scatter plot, the blindfolding method is said to perform similar to the bootstrapping method [243].

Any of re-sampling techniques could be used to determine the significance of the LVs. In this thesis, all resampling methods were employed to estimate the p values. As pointed out by Kock [243, 245], since warping algorithms are sensitive to the presence of outliers, it is suggested to examine the *p*-value of the latent variables using both bootstrapping and jackknifing method. The method that produces the most stable coefficient *p*-values, is recommended to be used to determine the significance of the LVs.

Table 5.15 shows the summary of different criteria for assessing the PLS model on the structural level, adopted from [2]. This thesis has used all these measures to assess the proposed structural model.

Criterion	**Description**	**Reference**
Coefficient of Determinant, R^2	Values of approximately .670 as substantial, values around .333 as average and values of .190 and lower as weak	[260]
Effect Size, f^2	A values of between .020 and .150, between .150 and .350 and exceeding .350 indicate whether a predictor LVs (exogenous LV) has a small, medium or large effect on an endogenous LV	[259]
Path Coefficient	Path coefficient between the LVs should be analyzed in terms of algebraic sign, magnitude and significance	[219]
Predictive Relevance, Q^2	$Q^2 > 0$ confirm the model's predictive relevance in respect of particular construct	[2, 237]

Table 4.6: Assessment of the Structural Model in This Thesis

4.12 Ethical Considerations

In order to ensure confidentiality of the data collected, the researcher undertook a number of procedures including:

- In the first phase of data collection, prior to final instrument development, the respondents names were kept confidential and their profiles were not discussed in such a way to allow them to be identified.
- The collected raw data has not been used for any other purpose except for the purpose of research.
- Once the raw data was downloaded from the web server onto the researcher's computer, the data in the provider server was deleted to ensure it could not be manipulated by unauthorised people.

4.13 Summary

This chapter outlines the research methodology used in this thesis. The need for quantitative methods with small section of qualitative data, using self-administered questionnaire is justified. The measurement items for each of the proposed latent variables have been developed using previously tested and validated scales and where new latent variables were introduced, the measurement items were developed from relevant literatures. The choice of sample has been justified followed by development and evaluation of measurement instrument. The statistical techniques used to examine the proposed research hypotheses have been elaborated. Further, two stage of model validation has been addressed. Ethical consideration conclude this chapter.

In the next chapter, preliminary data analysis are discussed followed by the results of analysis of measurement model and structural model.

Chapter 5

Analysis and Results of the Proposed Model

5.1 Introduction

This chapter presents the results of the analysis testing the proposed hypotheses. Section 5.2 presents the preparation of data which include data editing, coding and screening before conducting the PLS analysis. Section 5.3 presents the preliminary analysis of the data. Section 5.4 presents the response rate and sample characteristics. Section 5.5 presents the results on analyzing the effect of moderating factors. Following this, Section 5.6 reports the results of PLS-SEM which include the results of both the measurement model and the structural model. Further, Section 5.7 presents the additional results on qualitative data. This is followed by Section 5.8 which shows the types of relationship between latent variables (LVs). A conclusion is presented in Section 5.9.

5.2 Data Preparation

The first phase of data analysis is data preparation and description. According to Cooper and Schindler et. al. [36], *"data preparation includes editing, coding, and data entry and is an activity that ensures the accuracy of the data and their conversion from raw form to reduced and classified forms that are more appropriate for analysis"*. Figure 5.1 exhibits the steps involved in the preparation of data in this thesis (the diagram is adapted from Cooper and Schindler [36]). As shown in this figure, once the instruments have been pretested, the next stage is data collection and preparation. Collected data may be entered into a system using either a postcode or response-free method. In this thesis, the data was entered using a postcode method which will be elaborated further in next section. Once data were coded, the next stage was to edit the data to ensure that data are accurate, consistent and to check if any missing data was apparent. Once editing was completed, the data was ready to be analysed and interpreted, which is the final stage in data preparation.

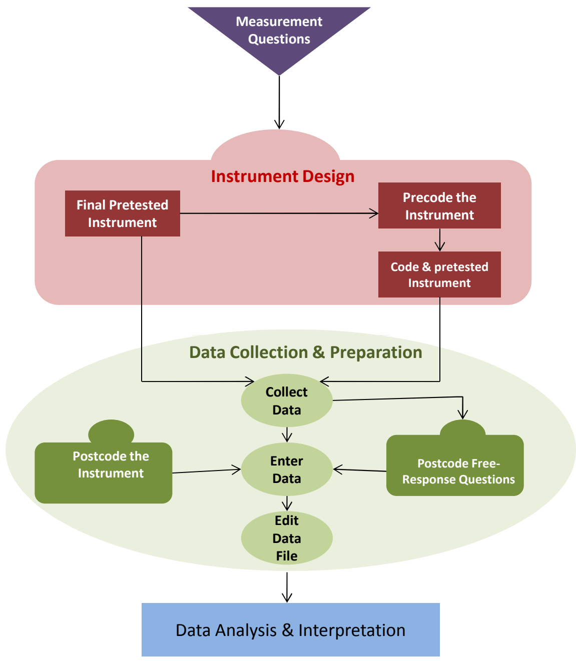


Figure 5.1: Data Preparation in the Research Process

5.2.1 Data Editing and Coding

The first step in performing data analysis is to edit the raw data. As pointed out by Cooper et. al. [36], the purpose of editing is *"to guarantee that data are accurate, consistent with the intent of the question and other information in the survey, uniformly entered, complete and arranged to simplify coding and tabulation"*. Editing is also needed in order to check for the presence of omissions. Missing data are considered as missing values [219]. In this thesis, all the responses for the Internet Survey (including drop-off approach) (described in Section 4.2.2) were saved at the Smart-Survey server. These responses were available for download at any time. When a sufficient number of responses was achieved (sample size of at least 60, as described in subsection 4.7.4), the data were downloaded and deleted from the provider server. This is to ensure that responses are used solely for the purpose of this thesis as part of ethical consideration (described in section 4.12).

The default format of the source data provided by the SmartSurvey is .csv and the file name associated with the source data was called raw data followed by specific code, for example in this thesis, the data file is called RawData–28739-292224-14-6-2011.csv. Editing of the data begin by converting the .csv file format into .xlsx format; the format used by WarpPLS software to analysis data.

The coding process involves assigning numbers or symbols to respondents' answers in order to grouped the answers into a limited number of categories [36]. In this thesis, the coding was performed to assign variable names to each measurement statement in the questionnaire. Each question represents a measurement item for its representative LV. Once the source file was assigned with the variable names it was uploaded into WarpPLS software to create the measurement model and to perform analysis on the data. The coding process can be undertaken before the questionnaire is answered (pre-coding) and after the questionnaire is answered (post-coding) [36]. In this thesis, the coding procedure adapted was post-coding and it was performed as follows:

- The raw data file recorded the data according to the questions number, in numerical values for example Q15.1, Q15.2, Q15.3.
- These question numbers were matched with the measurement items of the constructs. For example question 15.2 was measuring construct performance expectancy and measurement item no 2 i.e PE2.
- The new .xlsl excel file was created with each measurement items' name instead of question numbers such as SWQ1, PE3, IQ3, EE1, SI3 etc.

Table 5.1 and Table 5.2 show the question numbers and its associate measurement items.

Quest. No	Measurement Statement	Items	Construct
13.1	Given an opportunity, I will use the software in my health care practice	ITU-1	Intention to Use
13.2	I intend to use medically related software in my practice as frequent as possible.	ITU-2	Intention to Use
13.3	It is important that organization provides training and documentation which is specific to the job role of the user	FC-3	Facilitating Condition
13.4	I believe data confidentiality, data integrity and data availability are important features of any clinical related software	ISE-1	Information Security Expectancy
13.5	I believe it is important that internal technical assistances are available to solve problems related to the software.	FC-1	Facilitating Condition
14.1	It is important that outputs produced by medically related software are clear, precise, readable and consistent	IQ-1	Information Quality
14.2	I believe medically related software would provide all the necessary functions to perform my intended tasks related to health care practice	SWQ-1	Software Quality
14.3	It is important the software provides features that prevent unauthorized or disclosure of Information to protect data confidentiality or privacy issues.	ISE-2	Information Security Expectancy
14.4	I use the software because departmental co-workers also use it.	SI-1	Social Influence
14.5	I believe that outputs provided by medically related software would be to enable me to do required tasks.	IQ-2	Information Quality
15.1	I believe by using medically related software it would improve my effectiveness in the health care practice	PE-1	Performance Expectancy
15.2	By using medically related software it would make easier to do my job.	PE-2	Performance Expectancy
15.3	It is important that the software provides features which prevent or reduce users' error e.g. preventing medication error	ISE-3	Information Security Expectancy
15.4	I believe it is important that management provides a supportive working environment such as pleasant work place, sufficient work space, sufficient numbers of computers etc	MS-1	Management Support
15.5	I believe medically related software providers' supports are important to be available at all the time to solve problems related to software malfunction.	SERQ-1	Service Quality
16.1	It is important that management allows a reasonable transition period from previous medically related software to current software.	MS-2	Management Support
16.2	I believe it is important that medically related software is user-friendly.	EE-1	Effort Expectancy
16.3	I believe it would be relatively easy to retrieve records using medically related software.	EE-2	Effort Expectancy
16.4	I believe that medically related software provider need to have knowledge to do their job well (assurance).	SERQ-4	Service Quality
16.5	I believe medically related software would be easy to use and be helpful to the doctors, nurses and other clinicians in providing care to patients.	EE-3	Effort Expectancy
17.1	When there is a problem with medically related software, I believe it is important that service provider solves the problem at reasonable time period (reliability)	SERQ-2	Service Quality
17.2	It is important that necessary resources are provided by the management to be able the user to use the medical software.	FC-2	Facilitating Condition
17.3	Using medically related software would improve my job performance in the health-care practice.	PE-3	Performance Expectancy
17.4	People who are important to me think that I should use the software.	SI-3	Social Influence
17.5	It is important that medically related software provides output in understandable format.	IQ-3	Information Quality
18.1	It is important that the software provides features which prevent unauthorized modification of information to protect data integrity.	ISE-4	Information Security Expectancy
18.2	I believe using medically related software would improve my healthcare practice.	ITU-3	Intention to Use
18.3	It is important that introduction of new medically related software is communicated to the user of the software.	MS-3	Management Support
18.4	I believe medically related software would be easy to use, flexible and provides benefits to my health care practice.	SWQ-2	Software Quality
18.5	I estimate it would be easy for me to become skillful at using medically related software in my health care practice.	EE-4	Effort Expectancy
19.1	I estimate there would be high chance of me using medically related software in my health care practice.	ITU-4	Intention to Use
19.2	People who influence my behavior think I should use the software.	SI-2	Social Influence
19.3	I believe it is important that management provides encouragement to innovate and improve working practice through the use of medically related software.	MS-4	Management Support
19.4	It is important that medically related software's response time or speed meets the requirement of the health care practice.	SWQ-3	Software Quality
19.5	I believe by using medically related software it would enhance my productivity towards providing quality services to the public.	PE-4	Performance Expectancy

Table 5.1: Measurement Items for Each Construct and Its Supported References

Quest. No	Measurement Statement	Items	Construct
20.1	I believe it is important that management provides necessary support such as training, encouragement etc, which will encourage me to use medically related software.	PUTOF-6	Perceived user technology and organization fit (PUTOF)
20.2	Medically related software provider need to be willing to help and give prompt services to user (responsiveness).	SERQ-3	PUTOF
20.3	It is important that medically related software provides up-to-date information which is available 24/7 or whenever service is needed.	SWQ-4	PUTOF
20.4	I believe it is important that management provides me software that allows me to carry my health care practice effectively	PUTOF-5	PUTOF
21.1	I believe it is important that I have necessary skills and knowledge to use medically related software provided by the organization.	PUTOF-1	PUTOF
21.2	I believe it is important that management provides medically related software, which allows for convenient and easy access to the data	PUTOF-2	PUTOF
21.3	It is important that management ensures that medically related software is compatible with existing setting or architectures of the current software in the organization.	PUTOF-3	PUTOF
21.4	I believe it is important that management provides medically related software, which could provide secure, fast and reliable information and services at all time.	PUTOF-4	PUTOF

Table 5.2: Measurement Items for Each Construct and Its Supported References (Part 2)

5.2.2 Data Screening

After the editing and coding stage, is the screening stage in which screening for missing data and outliers is conducted. This is to ensure that there is no missing data and data have been entered correctly [182, 219].

Assessment of Missing Data

As pointed by Hair et. al. [219] *"researcher's primary concern is to identify the patterns and relationships underlying the missing data in order to maintain as close as possible the original distribution of values when any remedy is applied"*. Missing data usually occurs when a respondent fails to answer one or more questions. A four-step process for identifying missing data and applying remedies has been recommended [219]:

- Step 1 : Determine the Type of Missing Data.

  Two types of missing data are possible. One is *ignorable missing data* where specific remedies for the missing data are not needed. The second type of missing data is *not ignorable missing data*. This occur when respondents failed to complete the entire questionnaire.

- Step 2: Determine the Extent of Missing Data.

  According to Hair *et. al* [219], the direct means of assessing the extent of missing data is by looking at the percentage of variables with missing data and looking at the number of cases with missing data for each variable. The rule of thumb suggests that if missing data accounted for less than 10 % for an individual case it can generally be ignored, however not in a case when if it occurs in a specific nonrandom fashion [219]. The rule also suggest that when the number of responses are sufficient to perform selected statistical analysis there is no need to substituted the missing data [219].

- Step 3: Diagnose the Randomness of the Missing Data Process.

  This is to determine whether data are missing at random (MAR) or missing completely at random (MCAR).

- Step 4: Select the Imputation Methods.

  There are seven different imputation method including complete data, all available data, case substitution, hot and cold deck imputation, mean substitution, regression imputation and model based methods. Each of the method has its own advantages and disadvantages.

To summaries, there are two ways to evaluate the degree of missing data; to evaluate the amount of missing data and to evaluate what are the missing data i.e the patterns.

As described in Section 4.4, **section one** and **section three** of the questionnaire were expected to have some missing data and these data do not need any remedies because it is consisted of 'background' information of the respondents. The respondents may choose not to provide any information related to background information. **Section three** included general questions related to user opinion on 'fit' as well as user opinion on factors influence their acceptance of the software.

Section two in the measurement instrument is the main section of the questionnaire where all the the questions related to measurement items are included. This section was made compulsory. With the rule imposed during the development of measurement instrument, no missing data was found for the responses in this section of the questionnaire.

WarpPLS software used in this thesis will check and automatically correct any missing data found in the file. WarpPLS software carry out five main steps in the statistical analysis. In step three, it pre-processes the data and checks for missing data prior to performing SEM analysis. Figure 5.2 shows the screen shot, the missing data check performed by WarpPLS software. No missing data was found. WarpPLS also checked whether zero variance problem, identical column names and rank problem were presence in the analysis file.

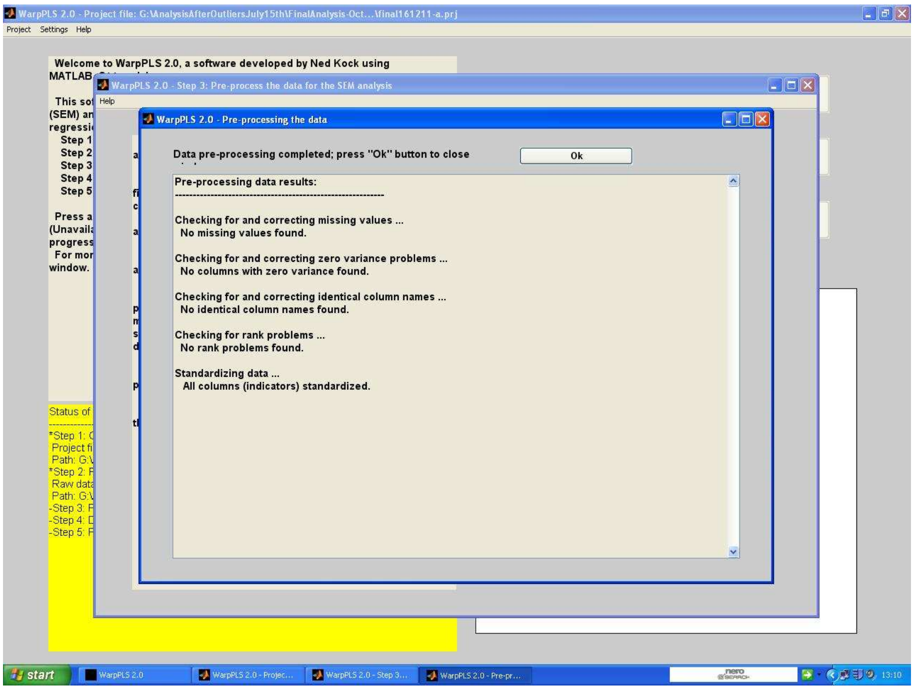


Figure 5.2: Screenshot shows the Results of Data Pre-Processing

The data used in the analysis in this thesis, did not suffer with any of above problems. Consequently, there was no requirement to assess the patterns of missing data as previously described. Furthermore, WarpPLS provides a features which automatically corrects any missing values using the column average method [243]. According to Hair et. al. [219], if no missing data is presented, there is no problem with the data and and therefore the data can be analyzed further .

Assessment of Outliers

The first step in examining the distribution of the latent variables is to check for the presence of outliers. Outliers is defined as *"observations with a unique combination of characteristics identifiable as distinctly different from the other observation"* [219]. The presence of outliers, either as very high or very low scores, could result in data which is not normally distributed as well as skewing of the results which is due to unexpected or unrealistic data. When outliers are detected, a decision needs to be made as to whether the cases should be retained or deleted [219].

In this thesis, outliers were detected using the Box and Whisker (BoxPlot) approach and 11 cases were identified and omitted. The remaining 102 responses were analyzed to test the hypothesized model. Figure 5.3 shows an example of outliers which present for management supports' measurement item. The following steps were taken to detect the outliers for each variable:

1. Using PASW version SPSS software, the data file was uploaded.
2. Using Box and Whisker (Boxplot) approach, the variable of interest was selected.
3. Where outliers were identified, the researcher referred back to the extreme case and decided whether or not that particular case needed to be removed. In this thesis, outliers were deleted, which in this case were for responses 7 and 81 (see figure 5.3).
4. Once outliers were removed, the next variable were analyzed using step 2 and 3.

Assessment of Common Method Variances

Common Method Variances (CMV) is *"variance that is attributable to the measurement method rather than to the construct the measures represent"* [231]. CMV is a subset of method bias which arises in quantitative research and could causes causes the measured relationships between two constructs inflate compared to its true value [261]. According to Straub et. al. [248], the problem with this bias is that it effects that cause a loss of construct validity are sometimes difficult to detect and are often not detected with a standard test for discriminant and convergent validity.

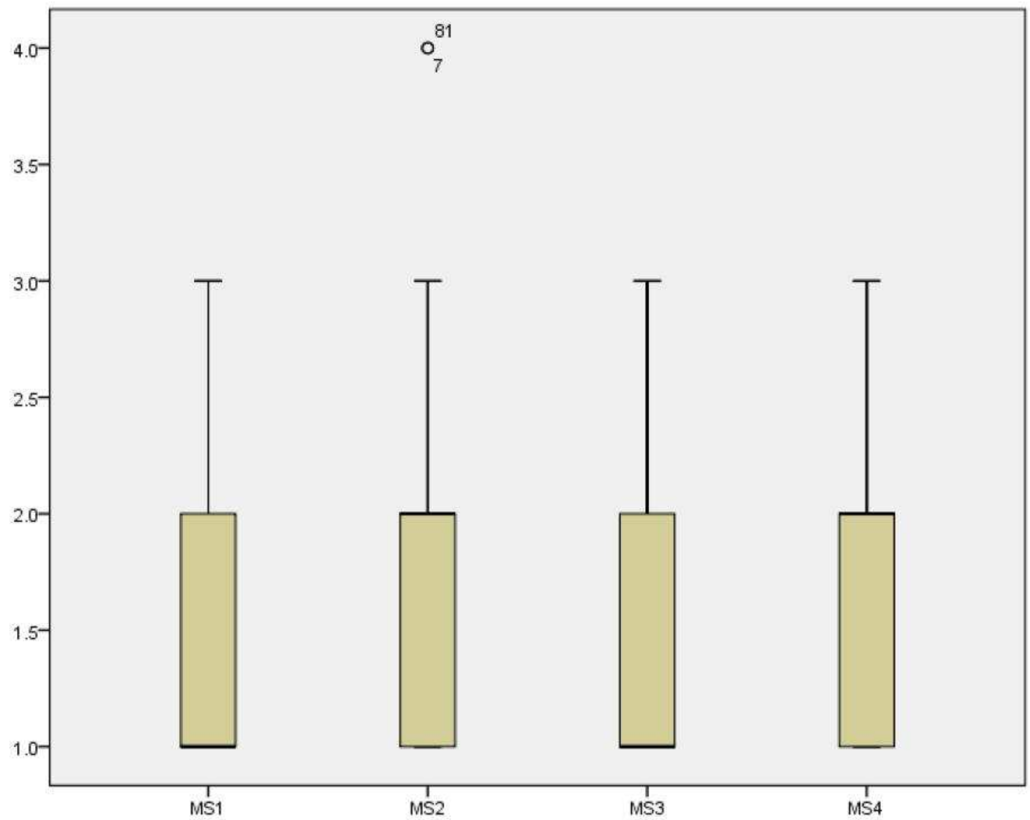


Figure 5.3: Outliers in Management Support Construct

In general, four approaches have been recommended to avoid or correct CMV [231]

1. Use other sources of information for some of the key measures. In particular, the dependent variables and independent variables both, should be constructed using information from different sources.

2. A number of procedural remedies in designing and administering the questionnaire, from mixing the order of the questions to using different scale types.

3. Complicated specifications of regression models reduce the likelihood of CMV.

4. Several statistical remedies are available to detect and control for any possible CMV. A post hoc Harman one-factor analysis is often used to check whether variances in the data can be largely attributed to a single factor.

In this thesis, remedies 1 and 2 above were implemented in the research design stage (described in section 4.3 and section 4.4). This process involves the way the questionnaire is designed and administered (remedy 2). For example, all the measurement items in this thesis were selected from various sources. The scales were adopted from those studies with valid and reliable measures of corresponding constructs. Further, the arrangement of measurement items within the questionnaire were also mixed.

According to Chang et.al. [262], remedy 3 is quite impossible to achieve because it implies that respondents need to have good cognitive maps. The author also argued that by adding complexity to the model such as mediating, moderating and/or non-linear effects to the model could only makes sense if it is guided by a good theory. Since this thesis is not adding any of these effects, remedy 3 was not employed.

Remedy 4 is adopted through the statistical approach. Using PASW Statistics 18 software, the data file was uploaded and factor analysis was performed. A Harman one-factor test was conducted to determine the extent of the common method variance. According to Podsakoff [231], common method bias is a problem if a single latent factor accounts for the majority of the explained variance. In this thesis, the un-rotated factor analysis showed that the first factor accounted for only 26.09 % of the total variance, hence the common method bias was not a serious threat for the data to be analyzed further.

5.3 Preliminary Data Analysis

Table 5.3 presents the descriptive statistics for the measurement items used in this thesis. The 5-point Likert scale was used to measure each item. Scale 5 represents 'strongly agree', 4 represents 'agree', 3 represents 'uncertain', 2 represents 'disagree' and 1 represents 'strongly disagree'. As shown in this table, most of the measurement items fall between strongly agree (5) to uncertain (3), except for measurement items measuring social influence factor (SI1,SI2,SI3).

Measurement		Likert	Scale		
Items	5	4	3	2	1
PE1	50%	43%	7%		
PE2	46%	47%	7%		
PE3	38%	54%	8%		
PE4	54%	40%	6%		
EE1	69%	29%	2%		
EE2	66%	31%	3%		
EE3	63%	35%	2%		
EE4	55%	39%	6%		
SI1	13%	28%	28%	21%	12%
S12	1%	23%	33%	28%	15%
SI3	3%	21%	42%	25%	10%
ISE1	68%	30%	2%		
ISE2	76%	23%	2%		
ISE3	70%	29%	1%		
ISE4	70%	28%	2%		
IQ1	69%	28%	4%		
IQ2	49%	40%	10%		
IQ3	57%	38%	5%		
SWQ1	62%	35%	3%		
SWQ2	58%	41%	1%		
SWQ3	55%	40%	5%		
SWQ4	63%	34%	3%		
SERQ1	56%	41%	3%		
SERQ2	66%	30%	4%		
SERQ3	28%	39%	8%	24%	1%
SERQ4	64%	36%			
FC1	55%	39%	6%		
FC2	50%	44%	6%		
FC3	53%	40%	7%		
MS1	61%	35%	4%		
MS2	49%	48%	3%		
MS3	55%	42%	3%		
MS4	42%	51%	7%		
PUTOF1	43%	49%	8%		
PUTOF2	59%	40%	1%		
PUTOF3	61%	37%	2%		
PUTOF4	54%	46%			
PUTOF5	60%	30%	10%		
PUTOF06	55%	43%	3%		
ITU1	64%	31%	6%		
ITU2	44%	5%	6%		
ITU3	58%	38%	4%		
ITU4	54%	36%	10%		

Table 5.3: The Probability of Each Measurement Items

5.4 Response Rate and Sample Characteristics

As discussed in the Methodology Chapter (Section 4.3.1) respondents in this thesis were medical students from various universities. Data collection started in December 2010 and finished in May 2011, for a period of six months. A total of 113 respondents participated in the study. A number of variables were incorporated within the instrument to describe the sample characteristics. These were gender, age range, year of study, university, faculty and country. Table 5.4 presents the demographics profile of the respondents. In regards to the year of study, the highest number of respondents were in second year of study (27.2%) followed by third year of study (24.6%), fourth year (15.5%) and first year (10.5%). The participants also came from various universities including University of Nottingham (39.8%), University of Leicester (17.7%), University Cork College Ireland (6.2%), University of Leeds (3.5%), and some others. Among the software indicated by the students as used or known about were iSOFT, ICM, Patient Discharge System, SystmOne, ETU, Patient Flow System, MedScape, NLE, CAL Packages, EMIS-Access and PACS.

Demographic Profile	Number of Respondents (N=113)	Percentages (%)
Gender		
Male	57	50%
Female	56	50%
Age		
<20 years	1	1%
20-29 years	92	81%
30-39 years	13	12%
40-49 years	4	4%
50-59 years	0	0
60+ years	0	0
Year of Study		
First Year	12	11%
Second Year	31	27%
Third Year	28	22%
Fourth Year	18	16%
Fifth or Final Year	11	10%
Other	10	9%
Nil	3	3%
University		
University of Nottingham	45	40%
University of Leicester	20	18%
University College Cork Ireland	7	6%
Royal College of Surgeons Ireland	5	4%
Trinity College Dublin Ireland	6	5%
University of Leeds	4	4%
Queen Mary University of London	4	4%
University of Newcastle	4	4%
Royal Devon and Exeter Hospital	3	3%
Others/Unspecified	15	13%

Table 5.4: Profile of the Respondents

5.5 Moderating Factor Analysis

As described in section 3.3, the influence of moderating factors is not hypothesized in the theoretical model. However, it is interesting to know students opinion of the influence of moderating factors on the acceptance of the medical software. Previous studies have analyzed the influence of moderating factors on actual usage of the system and among real user of the system [15, 33, 60, 187]. This thesis, however examines intention to use and the respondents were students. Table 5.5 summarize the results and shows that 82.3% of respondents believe that previous experience on different software for the same purposes would have an influence on their acceptance of the software. Further, 75.2% agreed that age would play a role in acceptance of new medical software. However, gender 32.7% was not shown to influence user acceptance of the software.

Factor	**Yes** (%)	**No**(%)	**Not Answered** (%)
Previous Experiences	93 (82.3)	17 (15.0)	3 (2.7)
Age	85 (75.2)	25 (22.1)	3 (2.7)
Gender	37 (32.7)	74 (64.5)	2 (1.8)

Table 5.5: The Influence of Moderating Factors on Students' Intention to Use Software

5.6 Analysis and Results of PLS Approach

The PLS-SEM is used to examine the hypotheses developed from the proposed theoretical model in **Chapter 3**. Based on the two-step approach recommended by Anderson et. al. [37], the measurement model is analyzed to test the reliability and validity of the measurement instrument and the structural model is analyzed to test the proposed research hypotheses. WarpPLS software examines both the measurement model and the structural model simultaneously to produce the results. The first stage which is measurement model stage, the analysis is conducted by specifying the relationships between the manifest variables and its proposed theoretical construct. Once achieved acceptable standard, as described in Section 4.10, the next stage is to test the causal relationships between exogenous (independent) and endogenous (dependent) constructs, in the structural model (Section 4.11). This thesis adopted the jackknife re-sampling method because it provides more stable results compared to the bootstrapping method [245] (Subsection 4.7.6).

5.6.1 Stage One : Assessing The Measurement Model

The measurement model is defined as *"an SEM model that (a) specifies the indicators for each construct and (b) enable an assessment of construct validity"* [219]. This means, the purpose of measurement model is to specify which measurement items are related to each latent variable. Each of the constructs under consideration; perceived user-technology-organization fit (PUTOF), performance expectancy (PE), effort expectancy (EE), social influence (SI), software quality (SWQ), service quality (SERQ), information quality (IQ), facilitating condition (FC), management support (MS), information security expectancy (ISE) and intention to use (ITU) are assessed for reliability features using factor loading. Validity is assessed using convergent and discriminant validity (described in section 4.10). If the results are not consistent with the prior specified measurement model then the measurement model should be respecified and reanalyzed [37, 219, 263].

Individual Item Reliability

The individual item reliability was assessed by looking at factor loading and cross-loading. The results of cross loading are presented in Table 5.6. The loading shows that all the measurement items loaded higher on the latent variables they are theoretically specified to measure than to other latent variables. The loadings are from a structure matrix (unrotated), and the cross-loadings from a pattern matrix (rotated) [243]. The structure matrix contains the Pearson correlations between indicators and latent variables [243]. Cross-loading indicates that all the 43 measurement items load distinctly on the specified latent variables they are meant to measure. As indicated in Table 5.6, all items loading exceeded the recommended value of 0.50 [219]. Thus, all the measurement items demonstrated a satisfactory level of individual item reliability.

Validity Assessment - Convergent Validity

For the convergent validity, factor loading, Cronbach's alpha, composite reliability and average variance extracted (AVE) were assessed (discussed in subsection 4.10.2). Warp-PLS 3.0 calculated these values from model estimates. Table 5.7 presents all these values for each of the latent variable.

	PUTOF	PE	EE	SI	FC	SWQ	IQ	SERQ	MS	ISE	ITU
PUTOF1	**0.671**	0.023	0.114	0.178	0.014	0.477	-0.109	-0.339	0.113	-0.046	-0.286
PUTOF2	**0.784**	-0.068	-0.035	-0.098	0.067	-0.396	-0.091	-0.077	0.186	0.204	0.039
PUTOF3	**0.775**	0.065	-0.199	-0.043	-0.150	-0.036	0.010	0.109	0.130	-0.177	0.153
PUTOF4	**0.496**	-0.210	0.094	0.050	0.099	-0.138	0.016	-0.043	-0.246	0.165	0.149
PUTOF5	**0.717**	0.076	0.044	-0.014	-0.018	-0.303	0.202	0.189	-0.126	-0.049	0.003
PUTOF6	**0.649**	0.056	0.043	-0.037	0.028	0.469	-0.024	0.138	-0.168	-0.059	-0.051
PE1	0.089	**0.861**	0.126	-0.075	-0.162	-0.230	0.141	-0.008	0.042	-0.057	0.042
PE2	-0.086	**0.719**	0.236	-0.008	0.029	-0.152	-0.108	0.023	0.321	0.083	-0.379
PE3	-0.131	**0.756**	-0.232	0.049	0.119	0.137	-0.197	0.092	-0.106	-0.017	0.156
PE4	0.117	**0.724**	-0.143	0.045	0.039	0.282	0.146	-0.110	-0.257	0.003	0.163
EE1	-0.122	-0.253	**0.742**	-0.146	-0.136	0.216	0.188	-0.121	-0.252	0.176	0.108
EE2	0.010	0.181	**0.813**	0.247	-0.123	-0.203	-0.253	0.036	0.356	0.171	-0.088
EE3	-0.059	0.159	**0.804**	0.058	-0.031	0.063	-0.129	0.047	0.087	0.096	-0.120
EE4	0.184	-0.123	**0.708**	-0.196	0.319	-0.064	0.240	0.031	-0.244	-0.491	0.124
SI1	-0.093	-0.143	-0.051	**0.829**	0.077	-0.079	0.079	0.160	0.010	-0.017	0.058
SI2	0.083	0.072	0.027	**0.912**	-0.033	0.110	0.024	-0.194	-0.083	0.006	-0.031
SI3	0.002	0.057	0.020	**0.918**	-0.037	-0.038	-0.095	0.048	0.073	0.009	-0.021
FC1	-0.095	-0.136	-0.075	0.029	**0.796**	0.053	0.068	0.139	-0.334	-0.054	0.149
FC2	0.046	0.075	-0.225	-0.116	**0.759**	-0.125	-0.102	0.201	0.424	0.100	0.070
FC3	0.054	0.067	0.303	0.085	**0.762**	0.069	0.030	-0.345	-0.073	-0.044	-0.225
SWQ1	0.064	0.040	0.174	0.010	-0.262	**0.659**	0.423	-0.160	0.043	-0.027	0.062
SWQ2	-0.019	-0.108	0.091	-0.120	0.250	**0.691**	-0.302	0.196	-0.269	0.118	0.095
SWQ3	0.070	0.053	-0.284	0.012	-0.017	**0.800**	-0.116	0.042	0.103	-0.123	-0.035
SWQ4	-0.115	0.008	0.067	0.091	0.019	**0.740**	0.031	-0.086	0.101	0.047	-0.107
IQ1	0.074	-0.010	0.094	-0.069	0.209	-0.040	**0.830**	-0.245	-0.104	-0.042	-0.067
IQ2	0.141	0.040	-0.130	-0.096	-0.021	-0.266	**0.743**	0.254	-0.190	-0.061	0.021
IQ3	-0.210	-0.027	0.024	0.163	-0.200	0.293	**0.790**	0.018	0.288	0.102	0.051
SERQ1	-0.054	0.068	-0.022	-0.070	-0.011	-0.207	-0.090	**0.738**	0.007	0.180	0.039
SERQ2	0.075	-0.025	0.069	-0.084	0.005	-0.061	0.377	**0.791**	-0.191	-0.279	0.136
SERQ4	-0.024	-0.038	-0.047	0.147	0.006	0.250	-0.288	**0.804**	0.182	0.109	-0.170
MS1	-0.066	-0.133	0.136	0.103	0.033	-0.366	-0.323	0.242	**0.674**	0.328	-0.266
MS2	0.061	0.017	0.129	-0.060	0.095	-0.007	0.309	-0.319	**0.749**	-0.166	0.074
MS3	0.130	-0.075	0.025	-0.075	0.021	0.073	0.119	0.168	**0.791**	-0.217	0.035
MS4	-0.167	0.219	-0.335	0.056	-0.177	0.313	-0.173	-0.091	**0.621**	0.121	0.155
ISE1	0.209	-0.051	0.054	0.055	0.582	0.098	0.427	-0.020	-0.467	**0.656**	-0.261
ISE2	-0.020	-0.123	-0.054	0.044	-0.051	-0.204	0.238	0.341	-0.535	**0.653**	0.271
ISE3	-0.218	0.076	-0.084	-0.117	-0.185	0.324	-0.358	-0.001	0.286	**0.754**	-0.143
ISE4	0.058	0.082	0.091	0.034	-0.305	-0.256	-0.241	-0.305	0.642	**0.685**	0.149
ITU1	-0.050	-0.103	-0.001	0.066	0.115	-0.190	0.066	-0.212	-0.009	0.216	**0.780**
ITU2	0.095	0.012	-0.011	-0.088	0.044	0.032	-0.027	-0.072	0.062	-0.163	**0.815**
ITU3	-0.039	0.051	0.107	0.059	-0.341	0.179	-0.110	-0.051	0.178	0.275	**0.743**
ITU4	-0.013	0.044	-0.094	-0.032	0.173	-0.015	0.070	0.352	-0.237	-0.323	**0.743**

Bold values are loadings for items which are above the recommended value of 0.5

Table 5.6: Loading and Cross-Loading of Each of Measurement Items (Individual Item Reliability)

As suggested by Hair et. al. [219] the loading for all items exceeded the recommended value of 0.50. Using 0.70 as a cut-off value of composite reliability all the latent variables demonstrated acceptable level of convergent validity. The composite reliability of the construct ranged from 0.782 to 0.917 which exceeded the recommended value of 0.70 [219]. Interpreted as a Cronbach's alpha for internal consistency reliability estimates, a composite reliability of 0.70 or greater is considered acceptable [249].

The results of AVEs are also shown in Table 5.7 which provides additional support for convergent validity. The average variances extracted (AVE) which measures the variance captured by the indicators relative to measurement error, should be greater than 0.50 to justify using the constructs [249, 251]. The average variance extracted were in the range of 0.500 and 0.787. Overall, the results shows that all 11 constructs, perceived user-technology-organization fit (PUTOF), performance expectancy (PE), effort expectancy (EE), social influence (IS), facilitating condition (FC), software quality (SWQ), service quality (SERQ), information quality (IS), information security expectancy (ISE), management support (MS) and intention to use (ITU) are all valid measures of their respective constructs based on their parameter estimates, exhibits reasonable convergent validity of the measurement models proposed in this thesis [219, 249, 250].

Construct	Measurement Items	Loadings	C.R	AVE
Perceived User-Technology-Organization Fit	PUTOF1	0.671	0.841	0.474 (0.500)
	PUTOF2	0.784		
	PUTOF3	0.775		
	PUTOF4	0.496 (0.500)		
	PUTOF5	0.717		
	PUTOF6	0.649		
Performance Expectancy (PE)	PE1	0.861	0.850	0.588
	PE2	0.719		
	PE3	0.756		
	PE4	0.724		
Effort Expectancy (EE)	EE1	0.742	0.852	0.590
	EE2	0.813		
	EE3	0.804		
	EE4	0.708		
Social Influence (SI)	SI1	0.829	0.917	0.787
	SI2	0.912		
	SI3	0.918		
Information Security Expectancy (ISE)	ISE1	0.656	0.782	0.474 (0.500)
	ISE2	0.653		
	ISE3	0.754		
	ISE4	0.685		
Software Quality (SWQ)	SWQ1	0.659	0.815	0.525
	SWQ2	0.691		
	SWQ3	0.800		
	SWQ4	0.740		
Service Quality (SERQ)	SERQ1	0.738	0.821	0.606
	SERQ2	0.791		
	SERQ4	0.804		
Information Quality (IQ)	IQ1	0.830	0.831	0.622
	IQ2	0.743		
	IQ3	0.790		
Facilitating Condition (FC)	FC1	0.796	0.816	0.597
	FC2	0.759		
	FC3	0.762		
Management Support (MS)	MS1	0.674	0.803	0.507
	MS2	0.749		
	MS3	0.791		
	MS4	0.621		
Intention to Use (ITU)	ITU1	0.780	0.854	0.594
	ITU2	0.815		
	ITU3	0.743		
	ITU4	0.743		

Table 5.7: The Internal Consistency Reliability and Convergent Validity of the Measurement Model- The Standardized Item loadings, Average Variance Extracted (AVE) and Composite Reliability (CR) of the Measurement Model

Validity Assessment - Discriminant Validity

As described in Subsection 4.10.3, discriminant validity is assessed by comparing the correlations between constructs and the square root of average variance extracted (AVE) for a construct. Table 5.8 display the correlation matrix for the constructs. The diagonal of the matrix contains the square roots of the AVEs which must be greater than off-diagonal elements in the corresponding row and columns to confirm with discriminant validity [219, 243]. As shown in this table, the diagonal elements are greater than the off-diagonal elements in the corresponding rows and columns [219]. The results show that there was no correlation between any two latent variables larger than or even equal to the square root AVEs of the two latent variables. The results demonstrate adequate discriminant validity for all constructs in the proposed conceptual model. Based on the analysis performed, the measurement model in this thesis demonstrated adequate discriminant validity which means that all the latent variables proposed in the hypothesized model are different from each other. In total, the measurement model in this thesis demonstrated adequate convergent validity and discriminant validity.

Constructs	PUTOF	PE	EE	SI	ISE	FC	MS	SWQ	IQ	SERQ	ITU
PUTOF	0.689										
PE	0193	0.767									
EE	0.399	0.341	0.768								
SI	-0.085	-0.221	0.025	0.8887							
FC	0.384	0.236	0.303	-0.027	0.772						
SWQ	0.509	0.370	0.576	0.088	0.439	0.724					
IQ	0.311	0.280	0.402	0.080	0.395	0.596	0.788				
SERQ	0.433	0.376	0.595	0.021	0.377	0.645	0.537	0.778			
MS	0.443	0.279	0.482	-0.057	0.534	0.663	0.624	0.612	0.712		
ISE	0.460	0.229	0.456	-0.033	0.543	0.553	0.620	0.550	0.486	0.688	
ITU	0.483	0.412	0.471	-0.045	0.440	0.488	0.340	0.336	0.446	0.405	0.771

Table 5.8: The Discriminant Validity of the Measurement Constructs

Reliability Analysis

Cronbach's alpha is used to assess the inter item consistency of the measurement items. Table 5.9 summarizes the loadings and alpha values. Cronbach's alpha of all latent variables ranged from 0.628 to 0.864 thus exceeded the recommended value of 0.60 [250]. Hence the results indicate that the measurement items are appropriate for their respective latent variables and reliable.

Construct	Measurement Items	Cronbach's Alpha	Loading Range	Number of Items
Perceived User-Technology-Organization Fit	PUTOF1 - PUTOF6,	0.772	0.500 - 0.784	6 (6)
Performance Expectancy	PE1 - PE4	0.764	0.719 - 0.861	4 (4)
Effort Expectancy	EE1 - EE4	0.767	0.708 - 0.813	4 (4)
Social Influence	SI1 - SI3	0.864	0.829 - 0.918	3 (3)
Information Security Expectancy	ISE1 - ISE4	0.628	0.653 - 0.754	4 (4)
Software Quality	SWQ1 - SWQ4	0.696	0.691 - 0.800	4 (4)
Service Quality	SERQ1 - SERQ4	0.674	0.738 - 0.804	3 (4)
Information Quality	IQ1 - IQ3	0.694	0.743 - 0.830	3 (3)
Facilitating Condition	FC1 - FC3	0.662	0.759 - 0.796	3 (3)
Management Support	MS1 - MS4	0.672	0.621 - 0.791	4 (4)
Intention to Use	ITU1 - ITU4	0.772	0.743 - 0.815	4 (4)

Table 5.9: Results of Reliability Test

Variance Inflation Factor for ITU

Variance inflation factor (VIF) measures the degree of multicollinearity among latent variables that are hypothesized to affect other latent variables. The VIF is assessed for formative constructs which, in the case of this thesis, is the intention to use (ITU) construct. Table 5.10 display the VIF for each of the measurement item for construct Intention to Use (ITU). As shown in the table, VIF for all these measurement items was all lower than 5.0 [219, 245, 253] which indicate the low degree of redundancy of each measurement items. Further, all the indicators have a significant level of indicator where $p<0.001$, which is within acceptable level for formative constructs' indicator validity.

Measurement Items	Indicator Weight	P value	VIF
ITU1	0.328	<0.001	1.595
ITU2	0.343	<0.001	1.726
ITU3	0.313	<0.001	1.433
ITU4	0.312	<0.001	1.465

Table 5.10: The Indicator Weights and Variance Inflation Factors

5.6.2 Review of Measurement Model (Stage One)

As the results in the above tables shows, each construct in the first stage was assessed through its observed variables (measurement items). In the first stage of model validation, the latent variables were assessed in terms of their reliability and and validity using three main property; individual item reliability, convergent validity and discriminant validity. Individual item reliability was assessed using factor loading. As shown in Table 5.6, loading of the measurement item exceeded the recommended value of 0.50 indicating the acceptable level of individual item reliability. Convergent validity was assessed using Cronbach's alpha, Composite Reliability (CR) and Average Variance Extracted. The results shown in Table 5.7 shows that all the values are above the recommended levels needed for this thesis which are 0.60 for Cronbach's alpha, 0.70 for CR and 0.50 for AVE. Third property, discriminant validity was examined through square root of AVE and the results shown in table 5.8 proved that each factor in the measurement model was empirically distinguishable. With satisfactory results for reliability and validity, the next stage is to perform the analysis of the structural model, in order to determine the explanatory power of the proposed model and to test the research hypotheses in this thesis.

5.6.3 Stage Two: Assessing Structural Model

Based on the results obtained in subsection 5.6.1, the measurement model has been shown to have good individual item reliability, convergent validity and discriminant validity. With all the values within acceptable standard limits, the measurement model in this thesis demonstrates sufficient robustness needed to test the relationship among the exogenous variable and the endogenous variables. The next stage is to assess the structural model with the aim to determine the explanatory power of the model and to test the proposed research hypotheses in **Chapter 3**.

The aim of this stage is to test all the proposed hypotheses in this thesis in order to answer the research questions outlined in **Chapter 1**. The causal structure of the model was assessed to examine the effects among the constructs defined in the proposed models through the estimation of the coefficient of determination (R^2), path coefficient, effect size (f^2) and predictive relevance.

These two R^2 values and path coefficient (loadings and significance) indicate how well the data support the hypothesized model [256, 260]. In the proposed theoretical model discussed in **Chapter 3**, in this thesis, the underlying constructs were classified into two classes; exogenous construct (perceived user-technology-organization fit) and endogenous constructs (performance expectancy, effort expectancy, social influence, software quality, service quality, information quality, facilitating condition, management support, information security expectancy and intention to use).

As shown in Table 5.11, the proposed hypotheses were presented in 11 casual paths (H_{1a}, H_{1b} ,H_{1c}, H_{1d}, H_{2a}, H_{2b}, H_{2c}, H_{3a}, H_{3b}, H_{3c}, H_{3d}) to determine the relationships under consideration for both types of constructs.

Hypotheses No.	Hypotheses
H_{1a}: PUTOF to PE	Perceived user-technology-organization fit will positively affect performance expectancy
H_{1b}: PUTOF to EE	Perceived user-technology-organization fit will positively affect effort expectancy
H_{1c}: PUTOF to SI	Perceived user-technology-organization fit will positively affect social influence
H_{1d}: PUTOF to FC	Perceived user-technology-organization fit will positively affect facilitating condition
H_{2a}: PUTOF to SWQ	Perceived user-technology-organization fit will positively affect software quality
H_{2b}: PUTOF to IQ	Perceived user-technology-organization fit will positively affect information quality
H_{2c}: PUTOF to SERQ	Perceived user-technology-organization fit will positively affect service quality
H_{3a}: PUTOF to ISE	Perceived user-technology-organization fit will positively affect information security expectancy
H_{3b}: ISE to ITU	Information Security Expectancy is positively associated with Intention to Use
H_{3c}: PUTOF to MS	Perceived user-technology-organization fit will positively affect management support
H_{3d}: MS to ITU	Management Support is positively associated with Intention to Use

Table 5.11: Proposed Hypotheses in This Thesis

Assessment of Coefficient of Determination, R^2

R^2 determines the prediction power of the model. WarpPLS 3.0 provided the R^2 for the dependent variables in the model. R^2 measures the relationship of latent variables (LVs) explained variances to its total variance [256]. Figure 5.4 shows the R^2 for each of the endogenous variables defined in the proposed theoretical model.

Assessment of Effect Size, f^2

Effect size measures of an independent LV has a substantial impact on a dependent LV [256, 259]. As stated by Urbach and Ahlemann [2], *"the effect size is calculated as the increase in R^2 of the latent variable (LV) to which the path is connected, relative to the LV's proportion of unexplained variance"*. Values of effect size between 0.020 and 0.150, between 0.150 and 0.350 and exceeding 0.350 indicate whether a predictor LV (exogenous LV) has a small, medium or large effect on an endogenous LV respectively [234,259]. The proposed hypothesized model in this thesis consists of one exogenous variable (PUTOF) and 10 endogenous variables. Table 5.12 presents the effect size of the endogenous variables defined in the theoretical model. PUTOF was shown to have small effects on three of the latent variables which are performance expectancy (0.113), social influence (0.134) and information quality (0.101). As shown, all these variables had an effect size between 0.020 and 0.150. PUTOF was shown to have a medium effect compared to the other remaining seven endogenous variables. As shown in this Table 5.12, the values of effect sizes were between 0.150 and 0.350.

Endogenous Variables	f^2	**Inference**
Performance Expectancy (PE)	0.113	PUTOF has *Small Effect* on PE
Effort Expectancy (EE)	0.164	PUTOF has *Medium Effect* on EE
Social Influence (SI)	0.134	PUTOF has *Small Effect* on SI
Facilitating Condition (FC)	0.168	PUTOF has *Medium Effect* on FC
Software Quality (SWQ)	0.266	PUTOF has *Medium Effect* on SWQ
Information Quality (IQ)	0.101	PUTOF has *Small Effect* on IQ
Service Quality (SERQ)	0.217	PUTOF has *Medium Effect* on SERQ
Management Support (MS)	0.201	PUTOF has *Medium Effect* on MS
Information Security Expectancy (ISE)	0.233	PUTOF has *Medium Effect* on ISE
Intention to Use (ITU)	0.329	Both MS and ISE constructs have *Medium Effect* on ITU

Table 5.12: The Effect Size, f^2, of the PUTOF Construct on Endogenous LVs

Predictive Relevance - Q^2

The Q^2 coefficient is a nonparametric Stone-Geisser test which was traditionally calculated using blindfolding [245] (this thesis uses jackknife and the analyses produced the same answers for Q^2 values). Q^2 used to assess the predictive validity (or relevance) associated with each latent variable in the proposed theoretical model. This is assessed by systematically assuming that some number of cases are missing from the responses whereby the model parameters are then estimated and used to predict the missing values [2]. Acceptable predictive validity for endogenous latent variables is suggested by a Q^2 coefficient is > 0 [2]. Table 5.13 shows the predictive relevance of each of the endogenous variables defined in this thesis.

Endogenous LVs	**Q^2 Values**
PE	0.104
EE	0.167
SI	0.120
FC	0.168
ISE	0.232
MS	0.206
SWQ	0.272
IQ	0.105
SERQ	0.219
ITU	0.333

Table 5.13: Results On Predictive Relevance of the Proposed Model

Further, WarpPLS 3.0 also produced the model indices or fit which are a useful set of measures related to model quality [243]. The model indices calculated by WarpPLs are average path coefficient (APC), average R^2 (ARS) and average variance inflation factor (AVIF) [243]. The fit indices are calculated as the average of: the (absolute values of the) path coefficients in the model, the R^2 values in the model, and the variance inflation factors in the model [243]. As described in Section 4.11.2, this thesis used WarpPLS 3.0 to analyze the proposed hypothesized model. WarpPLS produced ARS, APC and AVIF as an indicator of model fit. Table 5.14 shows the results of model indices.

Model Indices	**Value**
Average Path Coefficient	APC=0.401, $p<0.001$
Average R^2	ARS=0.193, $p=0.019$
Average Variance Inflation Factor	AVIF=1.280, Good if < 5

Table 5.14: Results On Model Indices of the Proposed Model

Assessment of Proposed Hypotheses

Once the validity of the structural model is confirmed, the next step is to assess the path of the proposed structural model. Figure 5.4 exhibits the structural model and the analytical results. Each path corresponds to each proposed hypotheses in this thesis. The test of each hypothesis is achieved by looking at the sign, size and statistical significance of the path coefficient (β) between the latent variable and its dependent variables. The higher the path coefficient, the stronger the effect of LVs on the dependent variable. Almost all the proposed relationships shows significance at $p<0.001$. The significance of the path coefficients was assessed using the jackknife function of WarpPLS 3.0 with 100 resample (the default value). Table 5.15 shows the proposed hyothesis and its results, whether supported or not. As shown, all except H_{1c} are supported in this study. Social Influence (SI) (β = -0.366, $p<0.001$), was not significant in the direction proposed, therefore, H_{1c} is not supported in this thesis.

Hypotheses	**Beta, β**	**Results**
H_{1a}: PUTOF to PE	0.336^{***}	Supported
H_{1b}: PUTOF to EE	0.405^{***}	Supported
H_{1c}: PUTOF to SI	-0.366	Not Supported
H_{1d}: PUTOF to FC	0.410^{***}	Supported
H_{2a}: PUTOF to SWQ	0.516^{***}	Supported
H_{2b}: PUTOF to IQ	0.318^{**}	Supported
H_{2c}: PUTOF to SERQ	0.466^{***}	Supported
H_{3a}: PUTOF to ISE	0.483^{***}	Supported
H_{3b}: ISE to ITU	0.230^{*}	Supported
H_{3c}: PUTOF to MS	0.449^{***}	Supported
H_{3d}: MS to ITU	0.429^{***}	Supported

Table 5.15: Structural Model Results

* $p<0.05$;
** $p<0.01$;
*** $p<0.001$

5.6.4 Review of the Structural Model (Stage Two)

This section reviews stage two of the model validation. At this stage, the structural model was examined on the proposed relationship between the latent variables based on the hypothesized model. The proposed structural model has been specified to test 11 paths

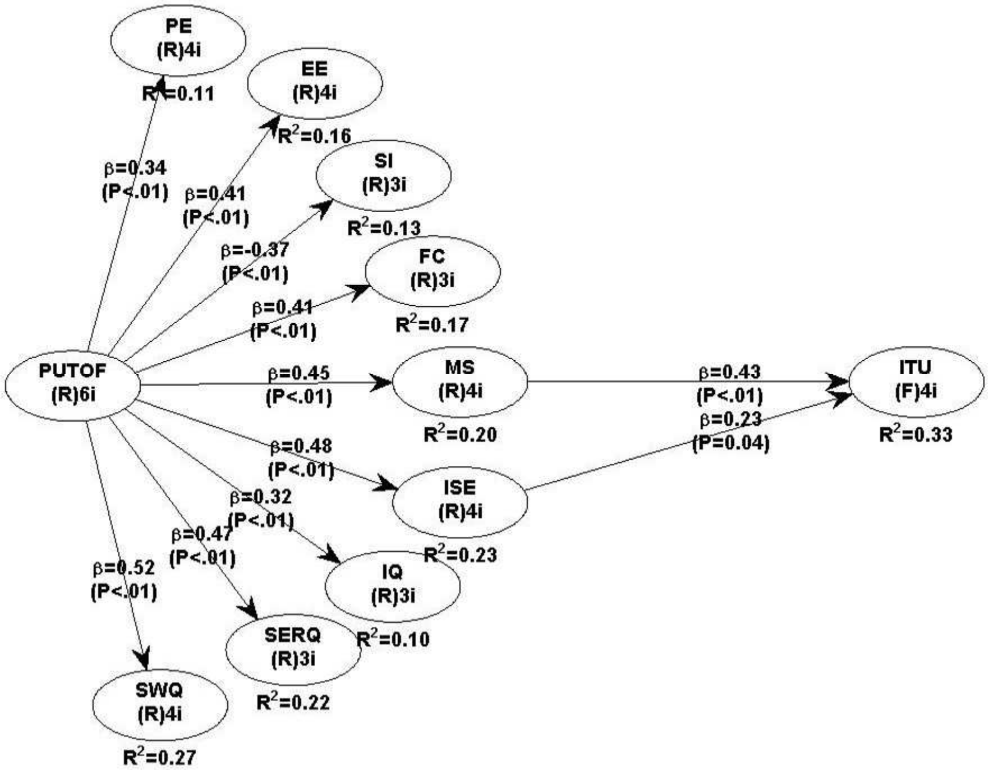


Figure 5.4: The Hypothesized Structural Model

which are represented in the hypotheses (H_{1a}, H_{1b}, H_{1c}, H_{1d}, H_{2a}, H_{2b}, H_{2c}, H_{3a}, H_{3b}, H_{3c}, H_{3d}). Based on the results obtained, one of the eleven paths representing H_{1c} was not significant in the direction proposed. The overall fit indices including Q^2, APC, ARS and AVIF, indicate that the hypothesized model best fits the data with (H_{1a}, H_{1b}, H_{1c}, H_{1d}, H_{2a}, H_{2b}, H_{2c}, H_{3a}, H_{3b}, H_{3c}, H_{3d}) accepted and H_{1c} rejected. Appendix C shows the full results of analysis using WarpPLS 3.0 software.

5.7 Analysis of Qualitative Data

As described in Section 4.4, section four of the questionnaire included one open-ended question (qualitative) where respondents were asked to express their opinion on what factors would influence their intention to use medical related software. 85.8% of the respondents answered the question, n=87 out of 102 analyzed data. The data were analyzed by categorizing the responses given according to the proposed constructs in the hypothesized model. The results are presented in Table 5.16 and Table 5.17 and show that the proposed theoretical model in this study could describe almost all the possible factors that influence students' acceptance or intention to use medical related software. The proposed model in this study has been examined among medical students rather than fully-qualified users of medical software; thus, caution needs to be exercised in generalizing the proposed model.

5.8 Relationship between Latent Variables

The WarpPLS also shows the types of relationships between latent variables, either warped or linear. The term "warped" is used for relationships that are nonlinear [243, 245]. The Warp3 PLS regression algorithm used in this thesis identifies relationships defined by a function whose first derivative is a U-shaped curve. As noted by Kock [243, 245], the results will show a relationship that has a linear form because *"the underlying algorithms find the type of relationship that best fits the distribution of points associated with a pair of latent variables and sometimes those types are not S-shaped curves or U-shaped curves"*.

Figure 5.5 shows the relationship between the perceived user-technology-organization fit construct (PUTOF) with performance expectancy. It shows a warped relationship between these variables. Figure 5.6 shows the relationship between PUTOF and information quality (IQ).

Proposed Construct	Responses
PUTOF	“If they help facilitate what I do at present”
	“A comprehensive integrated package”
	“I have the knowledge to use it”
	“the organization i.e to aid the sharing of information to all health care professionals such us receptionist, specialist, consultants etc.”
	“organization needs to allow me sufficient time to learn the new software before i actually using it”
	“practical to be used”.
	“flexibility to use my own word/sentence for each data entry, especially history and physical examination ”
	“..Compatibility with work and tasks and work burden..”
	“directly related to job specification.”
Performance Expectancy	“Whether it aids the job process i.e. speed up the work or slows down work productivity”
	“Time-saving purpose, efficiency in terms of service and reduced human error,”
	“The effectiveness of the software to improve job/task efficiency”
	“If it helps me, and the patient, I will use it...”
	“If its gonna increase job’s performance”.
	“perceived usefulness in providing care..”
	“..can improve my performance, beneficial to patients and medical professionals as well”
	“i will use the software if it make my job easier”
Effort Expectancy	“relevant and easy to use”
	“Useful, not over-sophisticated, not prone to crash, user friendly, helpful instead of complicating matters further”
	“Easy to trace clinical history of the patient including the medication prescribed in previous hospitalization / visits..”
	“ease of use and fit for purpose”
	“Easy to Use, Save time..”
	“user-friendly, Fast access to data/output, easy retrieve and access to data/output
	“the software should be user-friendly, easy to use and helps to save time..
	“ User friendly.. ”
	“User friendly, minimal error..”
	“fast, efficient, reduce paper consuming, less writing, easy to retrieve the documented record.”
	“How easy it is to use, how easily it can be used by all professions to see the same info about a patient”
	“how easy to navigate..”
	“ easy of use..”
	“ user-friendly- doesn’t really matter whether have been using the software before or not ..”
	“simple, user-friendly, efficient, simple lay terms for users..”
	“software allow me to do my job faster with no errors.”
Social Influence	“..but it makes the work of my colleagues easier, I might use it”
Facilitating Condition	“I need a proper training before using any software..:)”
	“i need to learn how to use it first ..”

Table 5.16: Responses on Qualitative Data and its Associated Constructs

Proposed Construct	Responses
Software Quality	"Reliability, Compatibility with work and tasks and work burden.."
	"..as well as providing an up-to-date information."
	"..should have back up file / document in black out situation"
	"..it should not be so complicated and shouldn't take long time to fill in whatever form in the software (less than 2 mins to complete the data).
	"The software must be up to date with reliable data.."
Information Quality	"Able to encode/decode/processing the data efficiently, Able to present the processed data in a simple and understandable way."
Service Quality	"..and readily available technical support in case the system/connection/equipments break down. "
	"those who provides the software need to be available to answer my questions if i have problem with the software. "
Management Support	"organization needs to allow me sufficient time to learn the new software before i actually using it"
Information Security Expectancy	" Not sacrificing Patients confidentiality"
	" reliable confidentiality
	"How reliable it is"
	"validity and confidentiality of patients data.."
	"its very important that software protect patients information as well as provide me with the authorization to use the software"
	"protect patient information"
	"as well as protecting the patients' data"
	"protecting important information"
	"Able to protect sensitive informations such as patient's data."

Table 5.17: Responses on Qualitative Data and its Associated Constructs

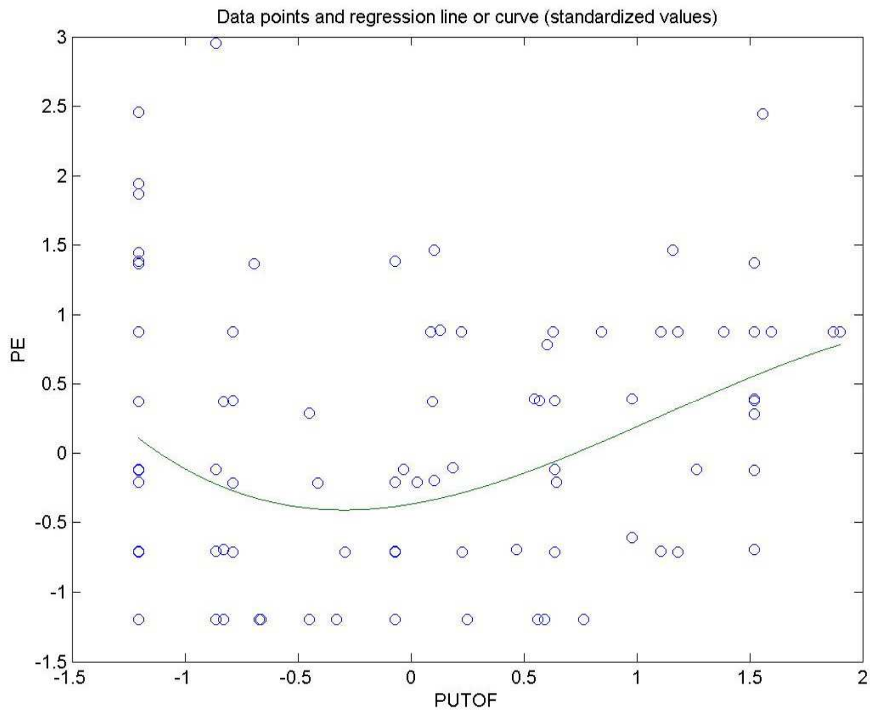


Figure 5.5: Non-linear relationship between PUTOF and PE

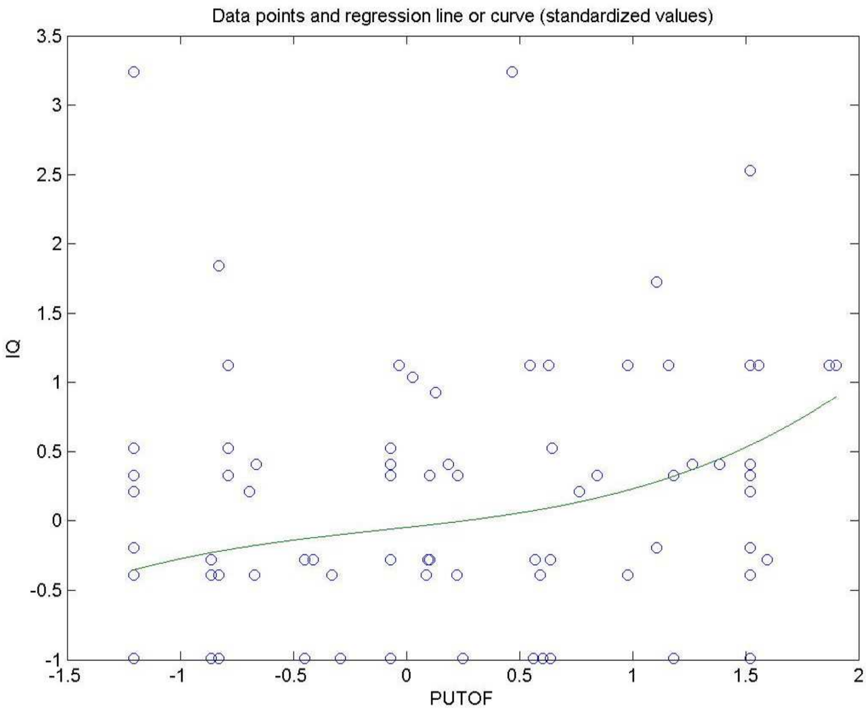


Figure 5.6: Non-linear relationship between PUTOF and IQ

5.9 Summary

The first stage of the data analysis was preparing the data prior to analysis. This was done by editing the data collected through the questionnaire and coding question items. Data screening was performed prior to PLS to examine any missing data and outliers as well as sample size. Once this was completed, the range of respondents was analyzed. Respondents ranged from first year of study (10.5%) up to final year of study (9.6%) and were sampled from different universities within the United Kingdom using simple random sampling as described in Section 5.4 above.

The second part of the data analysis was the use of PLS. This analysis was performed in two stages. In the first stage, the measurement model was assessed on construct reliability and validity. In testing the individual item reliability, factor loading was assessed. Results indicated that all constructs were reliable. Further, in order to confirm the validity of each construct, convergent, composite reliability and AVE were also assessed. Further, discriminant validity was also examined for each of the construct. As all the constructs were confirmed as valid and reliable, the constructs in this thesis were eligible for use in the next stage to test the hypotheses.

The hypothesized structural model was examined in the second stage including 11 paths representing the hypotheses (H_{1a}, H_{1b}, H_{1c}, H_{1d}, H_{2a}, H_{2b}, H_{2c}, H_{3a}, H_{3b}, H_{3c}, H_{3d}). One hypothesis was found not significant on the proposed path.

The next chapter discusses the results obtained in this chapter, in order to answer the research questions outlined in **Chapter 1**.

Chapter 6

Discussion of the Proposed Model

6.1 Introduction

Chapter 5 reported the results of testing the hypotheses identified in **Chapter 3**. This chapter interpreted those results in order to fulfill the aims of this thesis (section 1.2) by answering the four research questions outlined in **Chapter 1**. These are:

- What is the significant influence of perceived user-technology-organization fit (PUTOF) on performance expectancy, effort expectancy, facilitating condition and social influence factors in the context of user intention to use technology?
- What is the significant influence of perceived user-technology-organization fit (PUTOF) on system quality, information quality and service quality factors in the context of user intention to use technology?
- Does perceived user-technology-organization fit (PUTOF) influence management support and information security expectancy ?
- Are management support and information security expectancy important in influencing user intention to use technology?

This chapter is presented in nine sections. Following the introduction, the results obtained from testing the hypotheses are summarized in Section 6.2. The next four sections discuss the related results to answer the above research questions. Section 6.3 discusses the influence of PUTOF on constructs defined by the UTAUT model. Section 6.4 discusses the influence of PUTOF on constructs defined by the IS Success Model. This is followed by Section 6.5 which discusses the influence of PUTOF on management support and also information security expectancy. Further, Section 6.6 elaborates the influence of management support and information security expectancy on intention to use. Section 6.7 discusses the observation made on the R^2 values obtained in this thesis. Implication of this study which include theoretical and managerial issues are detailed in Section 6.8. Section 6.9 concludes this chapter.

6.2 Summary of the Results

This thesis tested an integrated model which was believed to lead to better understanding of the factor influencing user intention to adopt technology from a 'fit' perspective. The results in this Chapter need to be interpreted with caution due to the chosen sample of the population in this students. Compared to existing studies which examine the real use of technology among practitioners, this thesis examines medical students *intention to use* medical related software. Further, rather than specifying any specific software to validate proposed model, this thesis uses general medical software because the questionnaire was send to various medical schools across the United Kingdom. Since medical students belongs to various departments within the school or faculty, it is impossible to examine any single / specific medical software. These two limitations were taken into consideration in interpreting the results obtained, as discussed later in this Chapter.

In order to answer the research questions outlined in **Chapter 1**, the proposed theoretical model integrated three very well tested and validated models from the literature which are the Unified Theory of Acceptance and Use of Technology (UTAUT) [34], the DeLone McLean IS Success Model [35] and the Task technology Fit model (TTF) [30]. These were examined empirically as a single model in this thesis within medical students' sample. The TTF model is suggested to incorporate organizational fit together with task and technology 'fit' in this thesis. Although, the FITT framework [19], acknowledges the importance of the individual together with task and technology fit, this framework does not incorporate the organization 'fit' which could be understood from person-organization fit theory [31]. Further, as suggested by Ammenwerth et. al. [19], the FITT framework needs to be incorporated with other technology adoption models to better understand issues surrounding technology implementation, which is addressed in this thesis.

This thesis examined two new constructs which have not been tested elsewhere together with constructs defined by the UTAUT Model, the IS Success Model and the TTF model in a single model. As discussed in **Chapter 2**, the underlying variables used to examine the proposed model were conceptualized following a literature review by providing reliable and valid measures to measure these variables.

The results obtained in **Chapter 5** support the hypothesized relationships proposed in the theoretical model which has been tested among students' sample and medical related software. In particular, the results suggested that except for the social influence factor, all other factors (performance expectancy (PE), effort expectancy (EE), software quality (SWQ), facilitating condition (FC), information quality (IQ), service quality (SERQ), information security expectancy (ISE) and management support (MS)) are all positively influenced by perceived fit between the user, the technology and the organization (PUTOF). In addition, it has been found that the new constructs introduced in this thesis, which are information security expectancy (ISE) and management support (MS), both have significant influence on user intention to use software and to be positively influenced by perceived user-technology-organization fit. All these constructs have been examined within a sample of medical students, measuring their intention to use medically related software. The results shown in **Chapter 5** are discussed in more details in the following section.

6.3 The Effect of PUTOF on Constructs Defined by UTAUT

This section elaborates the results of examining the hypotheses related to the linkage between PUTOF with the constructs defined by the UTAUT model. One of the objectives of this thesis was to determine whether perceived user-technology-organization fit would have a positive effect on those left hand-side (exogenous) factors defined by both the UTAUT model and the IS Success model. This thesis identifies that there was a previous lack of knowledge about this relationship in the published literature, particularly with the inclusion of the organization fit within the user and the technology fit and the linkage between this construct with those constructs defined by other technology adoption models. Thus, this thesis will fill the gap that exists in the literature.

The hypothesized relationships were developed to answer the first research question as follows:

Q1: What is the significant influence of perceived user-technology-organization fit (PUTOF) on performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating condition(FC) factors in the context of user intention to use technology?

System success or failure of implementation (*from a user acceptance point of view*) often depends on the interaction between three components which are **user, technology and organization** and not the quality of the component themselves. Evaluating these components on their own for example evaluating only technology aspects fails to fully understand the problems associated with user acceptance. Rather it has to be understood from a 'fit' perspective, i.e how well the user, the technology and the organization are interacting with each other to achieve the intended objectives.

In the proposed model, it is hypothesized that perceived user-technology-organization fit (PUTOF) would have positive and significant effects on those exogenous constructs defined by the UTAUT model. Therefore, the first four hypotheses (H_{1a}, H_{1b}, H_{1c}, H_{1d}) were proposed, representing the influence of PUTOF on PE, EE, SI, and FC respectively.

This thesis examined the proposed hypothesis among medical students, measuring their intention to use medical related software, found mixed results for the relationship between PUTOF with these constructs. While PUTOF was found to have a strong positive relationship with performance expectancy (PE), effort expectancy (EE) and facilitating condition (FC), it did not have influence on the social influence factor. Since the sample of this study were students, the social factor was shown to have little influence on their intention to use the software. Thus, this factor, social influence is not supported, within the context of this study. Thus, this thesis provides support for only three of the hypotheses, (H_{1a}, H_{1b}, H_{1d}).

In order to better understand user acceptance issues, it is important to investigate how well the users interact with the technology introduced by the organization (suggested in this thesis as the construct called perceived user, technology-organization fit). The better the 'fit' between user, technology and organization, the better the effect on PE, EE and FC. This thesis suggests that the existence of these factors is dependent on the PUTOF factor. Although the proposed model was tested on medical students, it is believed that the results obtained could help to understand the role of PUTOF in influencing factors defined by existing technology adoption models, subsequently helping to find answers as to why the same system introduced in two different settings can result in two different outcomes.

The perception formed by the user that using certain technology would improve his or her job performance depends on how well the user perceives that he or she 'fits' with the technology. When a user believes that he or she 'fits' well with the technology, they will perceive that the technology will improve their job performance. Similarly, the influence of 'effort expectancy' on intention to use technology depends on how the user perceives that he or she 'fits' with the technology. When a user believes that the technology introduced by the organization 'fits' well with the skills or knowledge he or she already has, they will believe that using the technology will be easy.

Further, the facilities provided by the organization to influence user acceptance of the technology needs to match with user 'requirements'. Results from the first phase of study (discussed in Section 3.2), show that although students were provided with high resolution screens to facilitate the use of Distiller Software, the network speed in the City

Hospital itself was a problem. There was no problem with the software itself however, in order to use the software which is a web-based application requires a high speed network connection. Although, the management (City Hospital, Nottingham) has provided high resolution computer screens, it does not have the required network speed to use the Distiller Software. According to one of the research student, the low network speed causes such a delay on downloading the images needed to do the analyses that the student travels to Queens Medical Centre (QMC) to download them. This has subsequently delayed the students' research work.

On the other hand, research students who used the same resolution screens at the Queens Medical Centre (QMC) have no problem downloading images. The students based in QMC were generally happy with the Distiller Software and indicated that they would use the software in future. In contrast, research students based at City Hospital indicated that they would not use the software in future. These scenarios presented real examples of the 'fit' factor. The facilitating condition provided by the management at QMC, in terms of network speed shows the presence of good 'fit' between the user, the technology and the organization. The absence of the required network speed at City Hospital indicates a 'poor' fit between the user, the technology and the organization. The general users at City Hospital may have a 'good' fit with the network speed provided by the management but not for research student. These clearly show the facilitating condition provided by the management does not serve as a factor influencing user acceptance directly but needs to be incorporated with the 'fit' factor to explain differences in user acceptance, i.e the facility provided by the management needs to 'fit' with the task the users need to perform.

The findings in **Chapter 5**, section 5.6.3, suggested that the choice to use or not to use medically related software was decided independently without any influence of the Social Influence factor. Perceived user-technology-organization fit looks solely at how users interact with technology introduced by an organization, consequently the influence of peers on the acceptance of technology is insignificant. Based on results examined within students sample, this thesis found that regardless of whether other users (or students in the context of this study) or peer support for using the technology exist, the user themselves decides whether or not certain technology 'fit' the task they need to accomplished. In wider context, the studies which investigate the role of 'Social Influence' on user intention to use technology have given mixed results where some studies show a significant effect [34, 54, 196] and others shown no significant effect [15, 78, 79]. This thesis examined the significance of PUTOF on social influence within medical students and the results shown in **Chapter 5** suggested PUTOF did not significantly effect the social influence factor.

In sum, within the context of study in this thesis, it has been shown that the perceived user-technology-organization fit (PUTOF) has consequences on constructs defined by the UTAUT model which are effort expectancy (EE), performance expectancy (PE) and facilitating condition (FC) but not on social influence (SI).

6.4 The Effect of PUTOF on Constructs Defined by the IS Success Model

This section discusses the results of testing the hypotheses related to the linkage between PUTOF and those left-hand side constructs defined by the IS Success Model. This linkage aimed to answer the second research question.

Q1: What is the significant influence of perceived user-technology-organization fit (PUTOF) on Software Quality (SWQ), Information Quality (IQ) and Service Quality (SERQ) factors in the context of user intention to use technology?

In the proposed theoretical model, three more relationships were hypothesized, which, the exogenous constructs from the IS Success Model are influenced by perceived user-technology-organization fit (PUTOF) factor. Therefore, these hypotheses (H_{2a}, H_{2b}, H_{2c}) were proposed, representing the influence of PUTOF on software quality (SWQ), information quality (IQ) and service quality (SERQ) respectively. The results of this thesis demonstrated that all three constructs from the IS Success Model were influenced by the PUTOF construct. Hence, these results provide evidence to support H_{2a}, H_{2b}, H_{2c}.

The existence and influence of these three factors, software quality (SWQ), service quality (SERQ) and information quality (IQ) are dependent on the existence of the PUTOF factor. These three factors have a great influence on user acceptance or intention to use technology only when a user feels that the software provides all the necessary functionalities needed to accomplish related tasks. The features provided by the software need to fulfill the requirements of the task that the user needs to perform. The user interface, for example, may influence user acceptance depending on how easy or difficult it is to find required information. Senior users may prefer an easier and more simple user interface compared to younger users due to the fact they already get used to existing system or work operation. These two groups of users may have different acceptance levels of the same software, depending on how well the software 'fits' with the user. Thus, the influence of these three factors on intention to use technology depends on how well a user perceives he or she 'fits' with the technology introduced by the organization.

The quality of the software, the information quality of the software and the service quality provided by the software developer on its own cannot *guarantee* that the software will be accepted by the user. These features of the software need to 'fit' with the facility provided by the organization as well as 'fit' with the users' task requirements. In the case of the *Distiller Software*, in addition to the software itself two more requirements need to be fulfilled which are a high resolution screen computer and a high speed network. Absence of these would result in 'rejection' of the software, as happened with one of the research student in City Hospital. Thus, the presence of 'fit' between user, technology and organization would determine whether or not the software is accepted by the users.

6.5 The Effect of PUTOF on MS and ISE

This thesis hypothesized that ISE and MS are influenced by PUTOF and these two new constructs would have significant influence on user intention to use technology. The relationship were tested using H_{3a}, H_{3c} to answer the following research question.

Q3: Does perceived user-technology-organization fit (PUTOF) influence management support and information security expectancy?

This thesis demonstrated the influence of PUTOF on the management support and information security expectancy constructs from students' perspectives. When users believe that introduction of new technology or software will be accompanied with support from management, it is likely to influence their acceptance of the technology as shown in the study by [107]. Various support could be provided by the organization or management such as allowing ample transition time, providing a supportive working environment and encouragement to use technology especially at an early stage when the technology is first introduced. As described in Section 3.2, most research students accepted the *Distiller Software* for use in their research because of the support they received from their supervisor, Dr. Andrew Green, Senior Research Fellow based in the Division of Pathology, School of Molecular Medical Sciences, University of Nottingham. One student stated *"..if Andy didn't asked me to use this software, I would never had used it and he really helped me a lot with the software"*. This clearly illustrates the existence of 'fit' between user and organization, in this case, the supervisor who introduced the software to the students. The presence of this 'fit' would influence the role of management support and subsequently influence user intention to use the software. The empirical evidence presented in **Chapter 5** provides support for the inclusion of the management support construct within the model proposed in this thesis.

The results of this thesis were in agreement with previous research [107], which found that management support played an important role in identifying and clarifying the meaning of information systems to nurses and encouraged them to use the electronic information system.

The information security expectancy construct also shown to depend on perceived user-technology-organization fit (PUTOF) as hypothesized in this thesis. The perception users form on the existence of necessary security features especially on the issues of confidentiality, integrity and availability of data, results in the user believing in the existence of 'fit' between them and technology introduced by the organization. If a user does not believe that new software has the required security features, it will affect their acceptance and use of the software. This belief exists only when the user believes the organization has provided the right software which addresses security aspects. Although the study by Lu et. al. [115] looking at the security issues as being one of the barrier for the personal digital assistance (PDAs) adoption among health-care practitioners, this study provides similar view from students' population on security aspects. Inclusion of the information security construct would help management to understand factors associated with technology acceptance. The findings in this thesis also agree with the study conducted by Aibinu and Al-Lawati [224] which suggested concern among participants in electronic bidding regarding security issues.

6.6 The Effect of MS and ISE on Intention to Use

This thesis hypothesized that both ISE and MS would have significant influence on user intention to use technology. The relationship were tested using H_{3b}, H_{3d} to answer the following research question.

Q4: Are management support and information security expectancy important in influencing user intention to use technology?

These new constructs were examined in this thesis. As described in section 3.3, this thesis does not intend to explain the intention to use technology to the same extent as the original UTAUT, Delone and McLean IS Success Models and TTF because vast studies have already addressed these relationships [68, 70, 100, 186]. Since, ISE and MS were newly proposed constructs in this thesis, and were integrated in a single theoretical model, the relationships between these construct with ITU were hypothesized and examined to provide support on the inclusion of these two constructs on future user acceptance studies.

As was expected, both constructs, ISE and MS were found to have positive significant effects on intention to use. This thesis has demonstrated that in addition to constructs defined by both UTAUT and IS Success Model, these two new constructs, Information Security Expectancy (ISE) and Management Support (MS) were also important variables in predicting user intention to use technology or software. Both hypothesized relationship were supported by the empirical data which indicates the importance of these constructs in future studies related to technology acceptance.

Within health-care services, which deal with a vast volume of data including patients records, the security of data is crucial. When a new technology or software is introduced, the organization or management needs to ensure that features such as data confidentiality, authorization level, and back-up of files are carefully addressed. These features are important concerns among practitioners [27, 208] and would have great influence on their acceptance or intention to use technology or software. Within the context of this thesis, the importance of information security perception in influencing user intention to use technology was examined within a sample of medical students and the results show this construct to be important in influencing students intention to use medical software in future.

Further, the results in **Chapter 5**, also provide evidence of the importance of management support in influencing user (medical students) intention to use technology. This construct was examined through four items related to management support, described in section 5.7. Students viewed management support as a great motivation to influence their intention to use medical software. The importance of management support in influencing user intention to use technology has been shown in various studies, [23, 65, 195]. The results obtained in this thesis, researcher believes could provide additional support to the existing literature. This kind of support should be part of the organizational culture.

In answering the above research questions one, two, three and four above, this thesis fulfilled the first, second, third, fourth and fifth aims of the thesis proposed in section 1.2. This thesis makes a contribution to evaluation studies on user acceptance, by providing evidence of the linkage between perceived user-technology-organization fit and constructs defined by both the UTAUT Model and IS Success Model. Further, the use of PUTOF as a predictor of constructs defined by both models in a single model have been found to provide a better understanding on students intention to use medically related software. Importantly, the use of PUTOF as a predictor of construct defined by the UTAUT Model and the IS Success Model in a single model has been found to provide a more complete and comprehensive understanding on the user acceptance issue from a 'fit' perspective through evidence from empirical data.

6.7 Observation on Predictive R^2 Value

Compared to previous studies on technology acceptance [93, 100, 264], the hypothesized relationships proposed in this thesis have relatively low R^2 values (R^2=0.11 (PE), R^2=0.16 (EE), R^2=0.13 (SI), R^2=0.17 (FC), R^2=0.27 (SWQ), R^2=0.10 (IQ), R^2=0.22 (SERQ), R^2=0.20 (MS), R^2=0.23 (ISE), R^2=0.33 (ITU)). As pointed by Chin [260], *"models with single goodness of fit may still be considered poor on other measures such as R^2 and factor loading. The fit measure only relates to how well the parameter estimates are able to match the sample covariance. This does not relate how well the latent variables or item measures are predicted"*. This means that variables with low R^2 and or factor loading can still produce excellent goodness of fit. The results in **Chapter 5** show that although the the proposed model produced low R^2 values, the analysis on the proposed model did result in good model indices (see section 5.6.3) indicating the significance of the model in this thesis. Moreover, the R^2 of all predicted constructs in the proposed model in this thesis, were equal or greater than 0.10, which fulfilled the recommended value according to article by Kijsanayotin [70] [the author referring to Falk, R.F. and Miller, N.B., 1992. A Primer for Soft Modeling].

Nevertheless, there are several possibilities for the R^2 results obtained in this thesis. One possibility might be explained from the sample of the population chosen. In previous studies [64, 65, 265], the populations of interest were real users of the technology who could better provide responses to the given statements in the questionnaire because they have real experience of using the technology. However, in this thesis, the proposed theoretical model was empirically tested with medical students, who may not have used any medical software (although they may have knowledge of medical software). Thus, this could be one possible reason for the low R^2 values in this study.

Another possible reason could be, previous studies focus on specific types of software or technology whereas in this thesis, the software was indicated as medically related software which could be any software as long as it is used within a medical context. This thesis used 'medically related software' because the medical students may belong to one or many departments or specialties within the medical school and each department or specialty may have their own specific or specialized software, thus, it is quite impossible to specify any one medical software to test the proposed theoretical model. Moreover, this thesis used an Internet Survey to obtain the empirical data and was distributed to various universities. Specifying software in order to validate the proposed model would have resulted in a low response rate.

In addition to the above reasons, the theoretical model proposed one independent variable which is perceived user-technology-organization fit (PUTOF) and 10 dependent variables (DVs) which could also have contributed to the low R^2 values, compared to having one dependent variable and many independents variables as in many previous studies.

All of the above reasons could possibly contribute towards low predictive power of the proposed theoretical model. The fact that there exists various factors that could impact on technology acceptance apart from the 9 constructs introduced in the proposed model which could impact perceived user-technology-organization fit and subsequently technology acceptance and use, this study believe the variances explained by the model, R^2=0.11 (PE), R^2=0.16 (EE), R^2=0.13 (SI), R^2=0.17 (FC), R^2=0.27 (SWQ), R^2=0.10 (IQ), R^2=0.22 (SERQ), R^2=0.20 (MS), R^2=0.23 (ISE), R^2=0.33 (ITU), are substantial. Furthermore, this thesis, has demonstrated adequate construct validity and reliability of a measurement model related to the core constructs of the UTAUT model, DeLeon McLean IS Success Model and perceived user-technology-organization fit.

6.8 Implication of the Study

6.8.1 Theoretical Implication

Theoretically, in evaluation studies, issues surrounding user acceptance of technology is crucial. This is because in many scenarios the implementation of the systems failed or had poor fit [18, 23, 53, 67, 110] largely due to *rejection* from the user. To understand this issue, various published studies proposed factors and frameworks related to the user acceptance [15, 16, 86, 128–130], however, they have failed to address the issue of 'fit' as an important predictor of user acceptance. This thesis attempted to provide a model that can be used to better understand user acceptance issues. More specifically, this thesis has extended the research on user acceptance by investigating the influence of fit between user, technology and organization with those factors that could influence user acceptance which was measured from the perspective of medical students. The linkage reflects the necessity for understanding the role of 'fit' within evaluation work. It has been argued that the task and technology fit reflect the overall evaluation of user acceptance by employing this task-technology fit model within user acceptance models. However, the literature review demonstrated that organization fit together with individual fit and technology fit are necessary to address user intention issues, described in Section 2.7. Although the relationship between task and technology with constructs defined by the Technology Acceptance Model (TAM) has been investigated in previous research [95], evidence on this task-technology fit and its linkage with person-organization fit within the context of the user acceptance is, to the best of the researcher knowledge, new.

By examining the influence of perceived user-technology-organization fit (PUTOF) on factors associated with user acceptance, this thesis helps to understand the importance of the relationship between 'fit' and factors influencing user acceptance. In examining how students perceived their intention to use medically related software, the role of 'fit' has been shown to influence all factors defined by the hypothesized model except for Social Influence. This suggests that inclusion of PUTOF as a predictor of user acceptance factors in the proposed model, this thesis has made a contribution to the field of user acceptance by researching the importance of organization fit together with task-technology fit which to researcher knowledge has not been researched.

In furthering understanding of user intention to use technology or software, this thesis investigated the role of management support and information security expectancy. These two constructs further integrated with constructs defined by the Unified Theory of Acceptance and Use of Technology [34] and the DeLone McLean IS Success Model [35] in one single model. This thesis further attempts to clearly define each of the underlying constructs proposed in the theoretical model. Different measurement items, which suit the context of this thesis, were combined together to measure each of the constructs. Assessments of the reliabilities and validities of each construct confirmed the correspondence rules between both empirical and theoretical concepts [219]. Therefore, purified measurement items of this thesis provide useful direction for future empirical research into evaluation study.

6.8.2 Managerial Implication

The work in thesis could be classified as falling within evaluation research in health informatics research, focusing on (a sample of) medical students. The research focus is on the importance of perceived user-technology-organization fit factor as a determinant of all other factors that contribute towards acceptance and use of technology. The proposed model was examined through a sample of students and results were interpreted within this context of study. The knowledge acquired in this thesis could benefit hopefully organizations, developers, research communities and user themselves. Although this thesis measure the *intention* of students to use medical software, it is believed that the results could be generalized.

The results in this thesis, will benefit organizations who plan to adopt new medical software by understanding the importance of 'fit' between the user, the technology and the organization. If a new technology or software requires users to have specific knowledge or skills, the organization is responsible to ensure that the users have them by providing necessary training. It is also important that organizations develop an awareness of the value of software. Management need to make users aware of the benefits of the technology to the organization. Management could also improve acceptance by users by providing technology that fits with users skills and expectations. The more understanding management has about the importance of 'fit' between user, technology and organization, the more they will be able to successfully develop technology and manage implementation.

This study also has implications to developers of technology. The results demonstrate that software quality is most strongly influenced by the perceived fit between user-technology and organization (R^2=0.266). This implies that it is important for software developers to provides software that has quality meeting the requirements of the user and the organization as a whole.

Software or technology providers need to understand the influence of the 'fit' factor on the acceptance of the technology. The same technology or software may have been accepted in one setting yet may not be accepted in another setting due to differences in the 'fit' factor rather than the the technology itself. In other areas of implementation, performance expectancy, effort expectancy or even social influence could have significant effect on user acceptance compared to software quality factor itself [264]. Thus, it is important for software providers to understand that different factors contribute to user acceptance of technology and to provide software that meets user requirements and organization requirements accordingly as well as to understand the existence of differences in 'fit' factor between users of the technology. This will have a great impact on the system or software implementation in the organization.

6.8.3 Research / Academic Implication

From a researcher or academic perspective, the knowledge from this study attempted to emphasize the importance of perceived user-technology-organization fit as a predictor or core determinant of all other factors such as those defined by UTAUT, the IS Success Model as well as other technology acceptance models. This perceived user-technology-organization fit served as an exogenous factors into individual characteristics (PE, EE, ISE), technology characteristics (SWQ, SERQ, IQ) and organization characteristics (FC, MS). Future studies, looking at new constructs or existing constructs from previously validated technology acceptance factors, should relate these factors with the perceived user-technology-organization fit factor. Any newly defined construct should be able to be explained from the perceived fit factor. Depending on the type of technology, the setting or environment, users, various factors influence user intention or acceptance and use of technology, however the perceived fit factor should serve as the main determinant of these factors. The items measuring perceived user-technology-organization fit may also vary according to the technology or software under study, but the significance of this factor should not be ignored and should be part of future models to evaluate user acceptance issues. The proposed theoretical model in this study hopefully could guide direction for future research and evaluation studies on user acceptance.

6.9 Summary

This chapter discussed the results of PLS analysis which were presented in **Chapter 5**. Each of the research questions outlined in **Chapter 1** are answered and the aims of this thesis are shown to be fulfilled through the results obtained. The next chapter presents the second part of this thesis which examines the applicability of MCDA methods to answer the question of ‘which’ in user acceptance studies.

Part II

Addressing the Question of ‘Which’

Chapter 7

Addressing the Question of 'Which' in User Acceptance Studies

7.1 Introduction

Chapter 2 (Section 2.13) discussed the theoretical foundation to answer the final research question for this thesis. This chapter discusses the methodology used to evaluate the inclusion of the question of 'which' explicitly in evaluation studies, the results obtained and subsequently address the research questions outlined in **Chapter 1**. There are 14 sections to this chapter. After the introduction section, Section 7.2 discusses the phase 1 of the methodology. Section 7.3 discusses phase 2 of the methodology (design and justification of the quantitative methodology). Section 7.4 illustrates the development of the measurement instruments. Following this, Section 7.5 elaborates 3 methods used to assign weights to decision elements. The results obtained and analysis using all 3 methods are presented in Section 7.6 and the results obtained for the acceptance of research software are presented and discussed in Section 7.7. Section 7.8 discusses the comparison between the rankings of the acceptance of medical research software and research software. This is followed by Section 7.9 which discusses the applicability of MCDA in assigning weights to decision elements. Section 7.10 proposes the inclusion of additional dimensions into user acceptance studies (the question of 'which') and subsequently provides the answer to the proposed research question from **Chapter 1**. Meaning of the study in this thesis is presented in Section 7.11. Section 7.12 summarizes this chapter.

7.2 Phase 1: Structuring a Hierarchy Model of User Acceptance Factors

To answer the research question proposed in **Chapter 1**, this thesis adopted a three phase methodology as follows:

- Phase 1: Structuring a Hierarchy Model of User Acceptance Factors
- Phase 2: Measuring and Collecting data
- Phase 3: Determining the Normalised weights

In phase 1, the hierarchy model of user acceptance factors was first developed. Based on the theoretical background in **Chapter 2** (discussed in section 2.6), user acceptance factor are categorised within 3 dimensions which are user, technology and organization. To develop the hierarchy, these dimensions are recognised as factors. Within each factor, sub-factors related to it are listed. As shown in Figure 7.1, the problem of user acceptance which is addressed in this thesis are decomposed into a model with a hierarchical structure. Level 1 shows the goal of the problem which is intention to use, level 2 comprises of the user acceptance factors (individual (ind), technology (tech) and organization (org)) and level 3 comprises the nine sub-factors of user acceptance as identified in **Chapter 3**, which includes performance expectancy, effort expectancy, social influence, information security expectancy, software quality, service quality, information quality, management support and facilitating condition.

The decision problem is analyzed by dividing the decision element into factors and sub-factors. Comparison is made between these decision elements on lower hierarchical level relative to each of the elements on the next level. Every possible pair of lower-level elements is compared; each set requires $n(n-1)$ comparisons. This thesis did not assess in more detail issues on user acceptance but rather aimed to obtain information on the importance of each factor and sub-factor in order to establish rankings of the factors using various MCDA approaches. There may be differences between users' perception and software developers' perception on which factor contributes most toward acceptance. Software developers may perceive software factors itself (technology) most important in

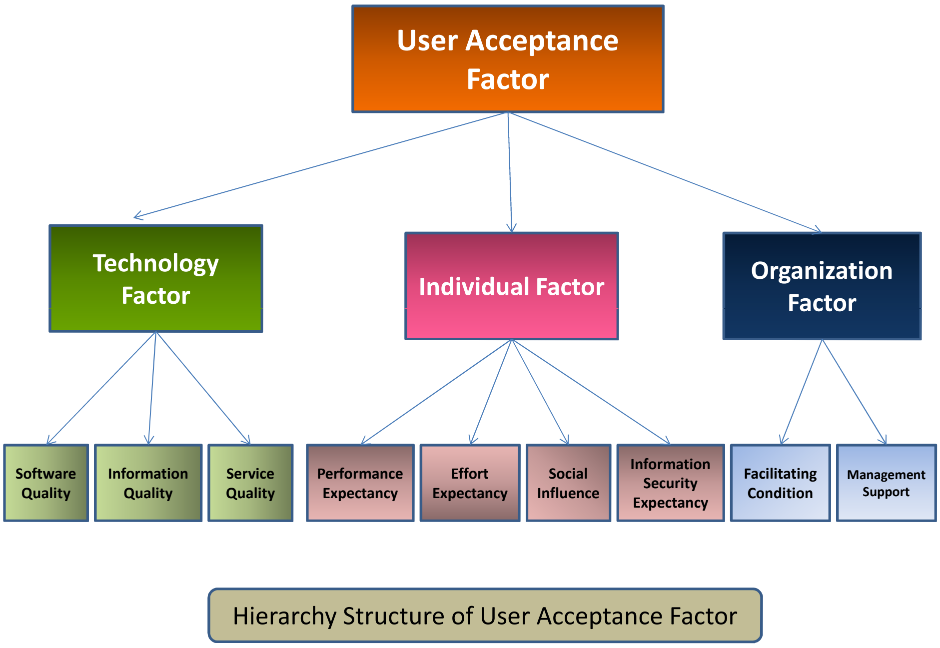


Figure 7.1: An AHP Hierarchy Structure of the Proposed User Acceptance Framework

influencing user acceptance while users may perceive their skills and knowledge of software as contributing most towards their acceptance of the software. Further, a number of studies address the issues of differences in perception of the success of information systems between users and software experts or developers [266–268]. By providing weights between these decision elements (user, technology, organization), the most influential factor can be identified and can help management to handle factors according to its level of importance.

7.3 Phase 2: Measuring and Collecting data

In order to answer the final research question listed in **Chapter 1**, this thesis employed a purely quantitative method to obtain the rankings of the factors and sub-factors by means of an **Internet Survey**. The following section describes the methodology employed to address phase 2 of the MCDA approach which is 'measuring and collecting data'.

7.3.1 Research Method

In order to obtain the relative importance of each factor and sub-factor, a survey methodology using a self-administered questionnaire was used for collecting data from the student population. In order to reach wide sample of population, a self-administered survey is the most appropriate tool [216, 217, 219]. The measurement instruments were developed using the Smart-Survey tool which is an on-line survey software. Once the questionnaires were completed, the list of medical schools within United Kingdom was compiled. The list was specifically obtained from medical school councils (www.medschools.ac.uk). The participating universities among many were University of Nottingham, University of Leicester, University of Leeds, Royal College of Surgeons Ireland, Queen Mary University of London, and others. A representative of each of the schools was contacted, to request their cooperation in forwarding the link to the mailing list of the students. The questionnaire link was then mailed to the schools representative who agreed to forward the link to the students' mailing list. Smart-Survey does not require a unique password rather the respondents are directed to the questionnaire when the link is clicked. Once the questionnaire is completed, the respondent clicks the submit button. All answers from the respondents are saved in the Smart-Surveys server. The data is available on-line and can be downloaded at anytime.

7.3.2 Sample of Study

There were two groups of respondents for this survey representing two types of software. The first group of respondents were medical students and the second group were research based students. Although the main objective of this thesis is to examine the suitability of the multi-criteria decision analysis (MCDA) approach in answering the question of 'which' in user acceptance studies, by sampling different kind of softwares and analyzing the level of importance of the factors and sub-factors for each kind of software provides additional information on whether different kinds of software have different levels of importance of the factors and sub-factors. The questionnaire related to medical software was sent to various medical schools (as described in Section 4.2.2). The questionnaire related to research software was emailed to the schools within the University of Nottingham including School of Computer Science, School of Education, Engineering, Arts etc. The email was specifically send to the school representatives and request their assistance in forwarding the link to the students' mailing list.

7.4 Measurement Instrument - Questionnaire

In order to conduct the survey-based research, two questionnaires were designed to gather data from sample. In terms of the format of questionnaires, it used mainly default features provided by the Smart Survey tool. The on-line survey commenced with an invitation to participate in the survey which stated the objectives of the questionnaire together with eligibility requirements and confidentiality and anonymity assurances with the contact details of the researcher [218]. The time to complete the survey was indicated to give an impression on how long time will be taken to answer the questionnaire. Wording was kept simple to ensure the respondents could understand the questions. The questions in both questionnaires were similar differing in which software was referred i.e. medically related software or research related software. Appendix D shows the developed questionnaire used in this study.

The end instruments had nine pages with a total of 42 questions. The questionnaire started with an invitation to participate in the survey. The second page covered demographic questions, including gender, year of study, university, department, experience with software, etc. The details of each of page in the questionnaire were as follows:

- Page Two: The first part of questionnaire contained 12 questions asking respondents about their gender, age, year of study, their university, school, country, whether they had used medical software and the name of any software used, the possibility of using medical software in the future as well as three questions on moderating factors (experience, gender and age).

- Page Three - Four: These pages included 12 questions related to individual factors. The question began by giving an instruction on the questions, followed by the definition of each of the constructs under consideration. The following question lists two constructs and asking the user to compare these constructs and choose the construct which had more influence on their acceptance of the software. This method is known as a pairwise comparison. This was followed by requesting the respondent to indicate the level of importance of the chosen constructs compared to the other construct. The options ranged from 'equally important' to 'absolutely more important'.

- Page Five: This page included six questions corresponding to technology factors which were software quality, service quality and information quality.

- Page Six: This page included two questions related to organization factors which were facilitating condition and management support.

- Page Seven: This page included six questions on the three factor categories (user, technology and organization). All the questions in this page were compulsory as indicated by an asterisk sign by each question.

Intensity	Definition	Explanation
9	Absolutely More Important	The evidence favoring one over other is of the highest possible validity
7	Much More Important	Experience and Judgment very strongly favor one over the other
5	More Important	Experience and Judgment strongly favor one over the other
3	Slightly More Important	Experience and Judgment slightly favor one over the other
1	Equally Important	Two factors contribute equally to the objective
2,4,6,8	Intermediate value	when comparison is needed.

Table 7.1: The Saaty's Nine-point Rating Scale ([3])

Linguistic Scale	TFN_{ij}	Reciprocal Scale
Absolutely More Important	(7,9,9)	(1/9, 1/9, 1/7)
Much More Important	(5,7,9)	(1/9,1/7,1/5)
More Important	(3,5,7)	(1/7,1/5,1/3)
Slightly More Important	(1,3,5)	(1/5,1/3,1)
Equally Important	(1,1,3)	(3,1,1)

Table 7.2: Triangular Fuzzy Conversion Scale ([4])

- Page Eight to Nine: These pages included questions related to each of the sub-factors and factors and asked respondents to consider the importance of these decision elements without making comparison with each other. The aim of these questions was to compare the ranking of the decision elements by means of pairwise comparison and without pairwise comparison. According to Salmeron and Herrero [142], pairwise comparison is a more reliable ways of obtaining the actual weights of the decision elements compared to obtaining them directly.

The responses for the questions in pages two to nine were compulsory. This were indicated as an asterisk sign next to each question. Respondents were asked to indicate the extent to which they felt each factors influenced their acceptance of the software through pairwise comparison methods using linguistic variables (ranging from 1 = equally important to 9 = Absolutely More Important) as shown in Table 7.1 [3]. When applying Fuzzy AHP for computation of the weights among the factors, this thesis used triangular fuzzy numbers (TFN) instead of crisp values. The triangular fuzzy conversion scale is shown in table 7.2 below [4]. The process of assigning the degree of importance continued for each level, until a series of judgment matrices for the factors and sub-factors was obtained.

7.4.1 Instrument Evaluation

Similar to the first questionnaire (described in section 4.5), the instruments were also evaluated using pilot study prior to main survey. The purposes of the pilot study was to identify any problems with the questionnaire itself, ensure word clarity, understandability, estimate how much time was needed to complete the questionnaire and to address any comments or suggestions respondents have [230, 233]. The pilot study involved distributing the draft of the questionnaire to a selected random sample of research students within the School of Computer Science School, University of Nottingham. 7 people agreed to participate in the pilot study which ran for a week in November 2010. A copy of the final survey instrument used for this thesis is provided in Appendix D.

7.4.2 Final Survey and Procedures

Following the pilot study, the questionnaire was edited to reflect suggestions and comments given by the students. The final survey was administered in December 2010. The questionnaires were developed using the Smart Survey tool and the links were generated. For the questionnaire related to medically related software, this link together with the link generated for the questionnaire developed to test the proposed theoretical model were emailed to the representative and coordinators of various medical schools across UK, around 20-30 email addresses (discussed in section 4.6). The choice of sample was described in details in subsection 4.3.1. This questionnaire were administered from December 2010 until February 2011 for a period of three months. The questionnaire of research related software, the target population was research students within the University of Nottingham. This questionnaire was also administered from December 2010 until March 2011 for a period of four months. The responses for each of the questionnaire is shown in Figure 7.2. As shown there are three different questionnaire developed.The second and third questionnaire related to this part of study. The second questionnaire send to various universities and resulted in 62 respondents. The third questionnaire which was send to research students within University of Nottingham resulted in 38 respondents.

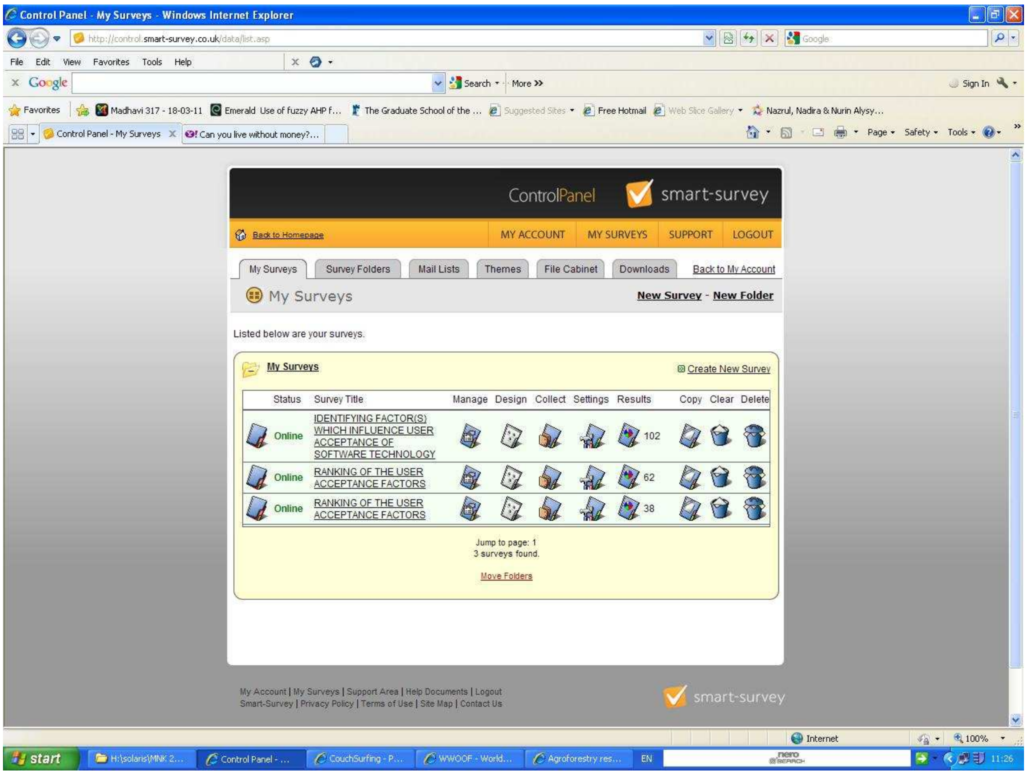
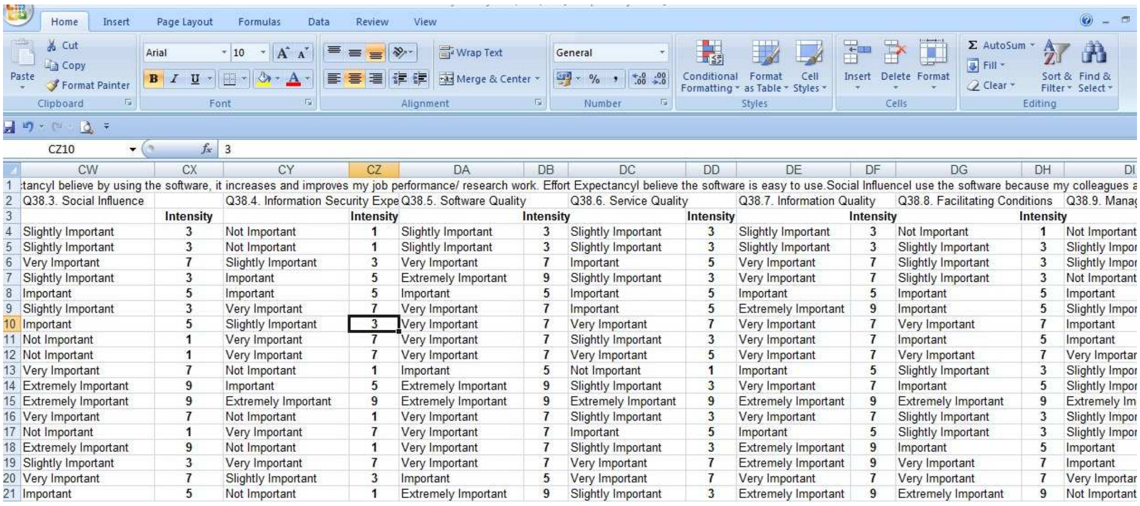


Figure 7.2: Screenshot showing the responses on all the questionnaires

7.4.3 Data Editing and Coding

The default format of the raw data file was .csv and the file name associated with the data was called raw data followed by specific code and then the date data was downloaded, for example RawData–28739-292224-14-6-2011.csv. To edit the data, it was transformed into an excel file which was used to perform the calculations using each of the methods; AHP, Fuzzy AHP. This thesis adopted the post-coding method [217]. The original, raw data file recorded the data on level of importance in linguistic terms. These responses were pre-coded into its associated numerical values. For example the answer ‘absolutely more important’ was pre-coded into the value of ‘9’ when classical AHP method is applied. Figure 7.3 shows how the responses coded into each associated intensity value. When the calculation of level of importance was performed using Fuzzy AHP, the triangular fuzzy number of (7,9,9) was used.



	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI
1	:tancyI believe by using the software, it increases and improves my job performance/ research work. Effort ExpectancyI believe the software is easy to use.Social InfluenceI use the software because my colleagues a												
2	Q38.3. Social Influence		Q38.4. Information Security Expe		Q38.5. Software Quality		Q38.6. Service Quality		Q38.7. Information Quality		Q38.8. Facilitating Conditions		Q38.9. Manag
3		Intensity		Intensity		Intensity		Intensity		Intensity		Intensity	
4	Slightly Important	3	Not Important	1	Slightly Important	3	Slightly Important	3	Slightly Important	3	Not Important	1	Not Important
5	Slightly Important	3	Not Important	1	Slightly Important	3	Slightly Important	3	Slightly Important	3	Slightly Important	3	Slightly Impor
6	Very Important	7	Slightly Important	3	Very Important	7	Important	5	Very Important	7	Slightly Important	3	Slightly Impor
7	Slightly Important	3	Important	5	Extremely Important	9	Slightly Important	3	Very Important	7	Slightly Important	3	Not Important
8	Important	5	Important	5	Important	5	Important	5	Important	5	Important	5	Important
9	Slightly Important	3	Very Important	7	Very Important	7	Important	5	Extremely Important	9	Important	5	Slightly Impor
10	Important	5	Slightly Important	3	Very Important	7	Very Important	7	Very Important	7	Very Important	7	Important
11	Not Important	1	Very Important	7	Very Important	7	Slightly Important	3	Very Important	7	Important	5	Important
12	Not Important	1	Very Important	7	Very Important	7	Very Important	5	Very Important	7	Very Important	7	Very Importar
13	Very Important	7	Not Important	1	Important	5	Not Important	1	Important	5	Slightly Important	3	Slightly Impor
14	Extremely Important	9	Important	5	Extremely Important	9	Slightly Important	3	Very Important	7	Important	5	Slightly Impor
15	Extremely Important	9	Extremely Important	9	Extremely Important	9	Extremely Important	9	Extremely Important	9	Extremely Important	9	Extremely Im
16	Very Important	7	Not Important	1	Very Important	7	Slightly Important	3	Very Important	7	Slightly Important	3	Slightly Impor
17	Not Important	1	Very Important	7	Very Important	7	Important	5	Important	5	Slightly Important	3	Slightly Impor
18	Extremely Important	9	Not Important	1	Very Important	7	Slightly Important	3	Extremely Important	9	Important	5	Important
19	Slightly Important	3	Very Important	7	Very Important	7	Very Important	7	Extremely Important	9	Very Important	7	Important
20	Very Important	7	Slightly Important	3	Important	5	Very Important	7	Very Important	7	Very Important	7	Very Importar
21	Important	5	Not Important	1	Extremely Important	9	Slightly Important	3	Extremely Important	9	Extremely Important	9	Not Important

Figure 7.3: Screenshot showing the assignment of linguistic responses to its numerical values

7.4.4 Data Screening

After the editing and coding stage, the next stage of data analysis was the screening stage. In this stage, screening for missing data was conducted. This is to ensure that no data was missing and that data had been entered correctly [182, 219]. Since all the questions on pages 2 to 9, in the questionnaire were made compulsory, no missing data were found in the source files of either questionnaire (medical software questionnaire and research software questionnaire).

In contrast, the first page of the questionnaire (discussed in section 7.4) was expected to have some missing data but did not need to be remedied because it consisted of background demographic information of the respondents and respondents may choose not to provide any information related to background information.

7.5 Phase 3: Determining the Normalised weights

The third phase of MCDA involved the process of determining the weights for the factors and sub-factors according to the methodology of each MCDA approach. As described in **Chapter 2**, Section 2.15, this thesis employed two well-known and widely used MCDA approaches which were Analytic Hierarchy Process (AHP) and Fuzzy Analytic Hierarchy Process (FAHP). The steps involved to determine the weights of the decision problems for each of the methods are detailed in the following sub-section.

7.5.1 Classical AHP

The basic steps involved in this methodology are as follows [145, 269]:

- Step 1: Set up the hierarchy structure by breaking down the decision elements (described in section 7.2)
- Step 2: Collect the input data by pairwise comparisons of the decision elements according to a given ratio scale (described in section 7.5)
- Step 3: Use the eigenvalue method to estimate the relative weights of the elements. Calculate approximation of maximum eigenvalue and the corresponding feature vectors of comparison matrix and check the consistency of the comparison matrix. To combine all users' opinions (all user's opinions were considered to be of the same importance), geometric mean as the aggregation method for the calculation of the average local and global weights is used [161, 162].
- Step 4: Check the consistency of the answers. Inconsistencies in the answers of the respondents may lead to different values. The closer to n, the greater the consistency of the answers. A normalised consistency ratio (CR), based on the divergence of the largest eigenvalue to n, is commonly used in the literature [269]. The maximum accepted upper value for the consistency ratio is 0.1 [3].
- Step 5: Aggregate these relative weights and synthesize them for the final measurements of given decision alternatives.

As indicated in step 4, the consistency of the answer need to be checked. Consistency refers to the property that if X is judged twice as important than Y and Y is judged two times more important than Z, then X should be judged four times more important than Z [140]. Consistency is checked by calculating a Consistency Ration (CR). CR measures how consistent the judgments have been to large samples of purely random judgments. This value is calculated by dividing the Consistency Index for a set of judgments by the Index for the corresponding random matrix. The Consistency index can be calculated from [3]:

$$C.1 = \frac{\lambda_{max} - n}{(n-1)} \tag{7.1}$$

Consistency Index table is shown in table 7.3 below.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Table 7.3: Random Consistency Index table (R.I)

Consistency Ratio is a comparison between consistency index and random consistency index which is calculated as follows [3].

$$C.R = \frac{C.I}{R.I} \tag{7.2}$$

Consistency ratios range between 0 and 1 with 0 indicating perfect consistency [3]. The standard definition of acceptable consistency is a consistency ration ≤ 0.10 [3].

All the responses were downloaded from the SmartSurvey server, the file was in .csv format. To begin performing the calculation the data were recorded in an Excel file. To determine the relative importance of the factors and sub-factors, the judgment matrices were translated into largest eigenvalue problems, and then the normalised and unique priority vectors of weights for each factor and sub-factor were computed using each of the approaches discussed above.

7.5.2 Fuzzy AHP: Chang's Method

Due to uncertainty in using fuzzy values in decision making problems, various publications adopt fuzzy number operations in Saaty's AHP method by using triangular fuzzy numbers [154, 159].

The theoretical fundamentals of Chang's extent analysis on FAHP are defined in four steps by taking into account the previous papers applying same methodology ([150, 161, 270]) in the literature. At the initial stage, the two sets, $X = x_1, x_2, x_3, ..., x_n$ as an object set and $G = u_1, u_2, u_3, ..., u_n$ as a goal set are defined. According to the principles of Chang's extent analysis, each object is considered correspondingly and extent analysis for each of the goal, g_i is executed. By doing so, it is possible to obtain the values of m extent analyses that can be demonstrated as $M_{g_i}^1, M_{g_i}^2, ..., M_{g_i}^m, i = 1, 2, ..., n, where M_{g_i}^j (j = 1, 2, ..., m)$ are triangular fuzzy numbers. Once initial assumptions are identified, Chang's extent analyses can be examined in four mains steps as follow [150, 161, 270]:

Step 1: The value of fuzzy synthetic extent with respect to the ith object is first defined

$$S_i = \sum_{j=1}^{m} M_{g_i}^j \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^j \right]^{-1} \tag{7.3}$$

To obtain $\sum_{j=1}^{m} M_{g_i}^j$, the fuzzy addition operation of m extent analysis values for a particular matrix is performed such as

$$\sum_{j=1}^{m} M_{g_i}^j = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j \right) \tag{7.4}$$

and to obtain $\left[\sum_{j=1}^{n} \sum_{j=1}^{m} M_{g_i}^j \right]^{-1}$, the fuzzy addition operation of $M_{g_i}^j (j = 1, 2, ...m)$ is performed such as

$$\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^j = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j \right) \tag{7.5}$$

then the inverse of the vector above is computed, such as

$$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^j \right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{n=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_j} \right) \tag{7.6}$$

Step 2: The degree of possibility of $M_2 = (a_2, b_2, c_2) \geq M_1 = (a_1, b_1, c_1)$ is defined as

$$V\,(M_2 \geq M_1) = sup_{y \geq x}\,[min(\mu_{M_1}(x)), \mu_{M_2}(y))] \tag{7.7}$$

and can be expressed as follows:

$$V\,(M_2 \geq M_1) = hgt(M_1 \cap M_2) = \mu_{M_2}(d) \tag{7.8}$$

$$= \begin{cases} 1 & \text{if } M_2 \geq M_1 \\ 0 & \text{if } l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & \text{otherwise} \end{cases} \tag{7.9}$$

where d is the ordinate of the highest intersection point D between μ_{M_1} and μ_{M_2} (see figure 7.4. To compare M_1 and M_2 we need both the value of $V(M_1 \geq M_2)$.

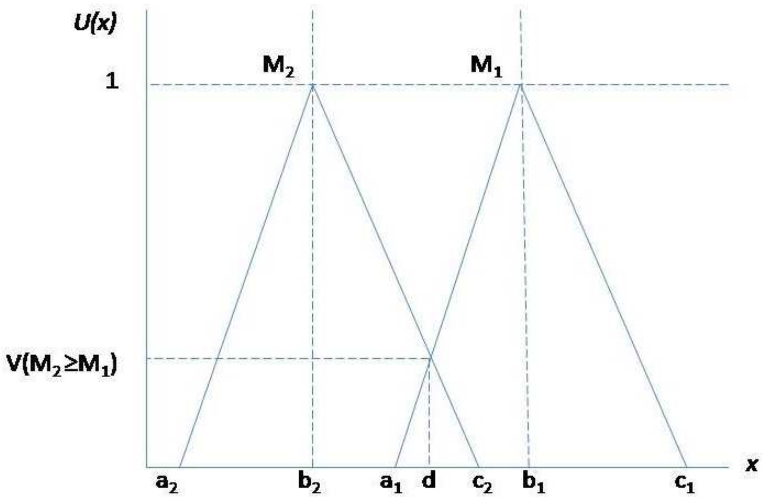


Figure 7.4: The intersection between M_1 and M_2

Step 3: The degree of possibility for a convex fuzzy number to be greater than the convex fuzzy number $M_i (i = 1, 2, ..., k)$ can be defined by $V(M \geq M_1, M_2, ..., M_k) = V(M \geq M_1)$ and $(M \geq M_2$ ... and $(M \geq M_k) = \min V(M \geq M_i)$,

$$i = 1, 2, 3, ...k. \tag{7.10}$$

Assume that

$$d'(A_i) = \min V(S_i \geq S_k) \tag{7.11}$$

For $k = 1, 2, ..., n; k \neq i$. The weight vector is given by

$$W^{'} = (d'(A_1), d'(A_2), ..., d'(A_i))^T \tag{7.12}$$

where $A_i(i = 1, 2, ..., n)$ are n elements.

Step 4: Via normalization, the normalised weight vectors

$$W = (d(A - i), d(A_2), ...d(A_n))^T \tag{7.13}$$

where W is a non-fuzzy number.

The normalised weights for each factor and sub-factor were calculated using the same data file according to the methodology of each method. The results of the analysis using Fuzzy AHP Chang's Method are discussed in the subsection 7.6.3 and subsection 7.7.3.

7.5.3 Fuzzy AHP: α and λ method

The third method applied in this thesis is derived from Csutora and Buckley [163] who developed the Lambda-Max method, which is a direct fuzzification of the well-known λ max method. Similar to Chang's method, this method also explicitly expresses fuzzy perceptions. This method is differentiated from others through the use of a preference α and a risk tolerance λ of the decision maker [162]. In this thesis, researcher assigned 0.5 for α which represents that environmental uncertainty is steady and $\lambda = 0.5$ which represents that future attitude is fair [160, 162].

Relative weights of the factors were calculated as follows, adopted from Lin and Chang et. al. [160, 162]:

Step 1: Establishment of triangular fuzzy numbers.
According to Lin et. al. [162], each number in the pair-wise comparison matrix represents the subjective opinion of decision makers. Since subjective opinion is an an ambiguous concept, fuzzy numbers is believed to work best to combine various decision makers opinion. As Saaty [151] argued that the geometric mean would represent the consensus of experts and the geometric mean is used as the model for triangular fuzzy numbers. Also the mean of membership = 1 where U denotes the minimum numerical value and L is the geometric mean, which represents the consensus of most experts. Consequently, the values within L and U represent the possibilities for different consensuses, this is shown in figure 7.5 below.

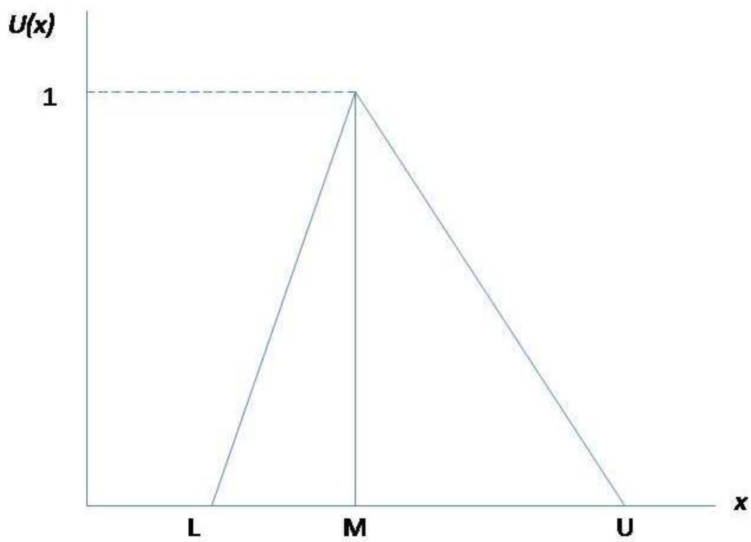


Figure 7.5: Triangular fuzzy Numbers

The triangular fuzzy numbers $\tilde{u}_{ij}$ are established as follows:

$$\tilde{u}_{ij} = (L_{ij}, M_{ij}, Uij) \tag{7.14}$$

$$L_{ij} \leq M_{ij} \leq U_{ij} and$$

$$L_{ij}, M_{ij}, U_{ij} \in [1/9, 1] \cup [1, 9]$$

$$L_{ij} min(B_{ijk}) \tag{7.15}$$

$$M_{ij} = \sqrt[n]{\prod_{k=1}^{n} B_{ijk}} \tag{7.16}$$

$$U_{ij} = max(B_{ijk}) \tag{7.17}$$

where B_{ijk} represents a judgment of expert k for the relative importance of two criteria i and j.

Step 2: Establishment of fuzzy pair-wise comparison matrix

$$\tilde{A} = \left[\tilde{a}_{ij}\right] = \begin{bmatrix} 1 & \tilde{a}_1 2 & ... & \tilde{a}_1 n \\ \frac{1}{\tilde{a}_{12}} & 1 & ... & \tilde{a}_{2n} \\ . & . & . & . \\ . & . & . & . \\ \frac{1}{\tilde{a}_{1n}} & \frac{1}{\tilde{a}_{2n}} & ... & 1 \end{bmatrix} \tag{7.18}$$

where $\tilde{a}_{12}$ denotes a triangular fuzzy matrix for the relative of importance of two criteria C_i and C_2.

Step 3: Defuzzification.

Defuzzification displays the preference (α) and risk tolerance (λ) of decision makers [271]. α could either be stable or fluctuate depending on the uncertainity in decision making. The range of uncertainty in decision making is the greatest when $\alpha = 0$, and the value of α lies between 0 and 1. As desrcibed by Lin *et. al* [162], while $\propto = 0$ represents the upper-bound Uij and lower bound Lij of triangular fuzzy number and while $\propto = 1$ represents the geometric mean in triangular fuzzy number, λ can be viewed as as the degree of a decision maker's pessimism. Further, when this λ is equal to 0, the decision maker is said to be more optimistic and therefore the expert consensus is upper-bound Uij of the triangular fuzzy number. On the other hand, when $\lambda = 1$, the decision maker is pessimistic and the number ranges from 0 to 1. Five numbers 0.1, 0.2, 0.5, 0.7 ,0.9 could be used to emulate the state of mind of decision makers,

$$(a_{ij}^{\alpha})^{\lambda} = \left[\lambda . L_{ij}^{\alpha} + (1-\lambda) . U_{ij}^{\alpha}\right], 0 \leq \alpha \leq 1, 0 \leq \alpha \leq 1 \tag{7.19}$$

where $L_{ij}^{\alpha} = (Mij - Lij).\alpha + Lij$, represents the left-end value of α-cup for $a_{ij}.U_{ij}^{\alpha} = U_{ij} - (U_{ij} - M_{ij}).\alpha$, represents the right-end value of α-cup and for α-cup for a_{ij}.

Step 4: Eigenvalue and eigenvector $\bar{\lambda}$ is assumed to be the eigenvalue of the single pair comparison matrix $(A^{\alpha})^{\lambda}$

$$(A^{\alpha})^{\lambda}.W = \bar{\lambda}max.W \tag{7.20}$$

$$\left[(A^{\alpha})^{\lambda} - \bar{\lambda}max\right].W. \tag{7.21}$$

where w denotes the eigenvector of $(A^{\alpha})^{\lambda}, 0 \leq \lambda \leq 1, 0 \leq \lambda \leq 1$

Step 5: Consistency Check

Saaty [3] proposed to utilize consistency index (C.I) and consistency ration (C.R) to verify the consistency of the comparison matrix. C.I. and C.R are defined as follows:

$$C.I = \frac{\lambda_{max} - n}{(n-1)} \tag{7.22}$$

$$C.R = \frac{C.I}{R.I.} \tag{7.23}$$

where R.I represents the average consistency index over numerous random entries of same order reciprocal matrices. If C.R ≤ 0.1, the estimates is accepted, otherwise, a new comparison matrix is solicited until C.R ≤ 0.1 [3].

7.6 Data Analysis and Results - Medical Software

7.6.1 Response rate and Sample Characteristics

An on-line questionnaire was distributed to the medical schools of various universities in the UK from December 2010 until March 2011. 38 users responded to the questionnaire. Among these, 14 of them were male and 24 were female. 29 of the respondents were within 20-29 years old, 7 were between 30 to 49 years old, and two were above 50 years old. In terms of respondents' year of study, 1 was a first year student, 10 were second year students, 13 were third year students, 3 were fourth year students, 4 were fifth year students and 3 were in the 'other' category.

Among the software indicated by the students as used or known about are iSOFT, ICM, Patient Discharge System, SystmOne, ETU, Patient Flow System, MedScape, NLE, CAL Packages, EMIS-Access and PACS. Respondents were asked to indicate the extent to which they felt factors influenced towards their acceptance of research software through the pair-wise comparison method using linguistic variables (ranging from 1 = equally important to 9 = Absolutely More Important) as shown in Table 7.1. When applying Fuzzy AHP for computation of the weights among the factors, fuzzy triangular numbers (TFN) was used instead of crisp values. The process of assigning the degree of importance continued for each level, until eventually a series of judgment matrices for the factors and sub-factors was obtained.

7.6.2 Result - Classical AHP Approach

Table 7.4 shows the AHP pairwise comparison matrix for the individual, technology and organization factors. By applying steps 3 and 4 described in section 7.5.1, the normalised value were computed followed by local weights for each of the factor shown in Table 7.5. Using the classical AHP method, the results show that the technology factor was the most influential factor in students' acceptance of the medical related software. A consistency check was done for all the normalised matrices and was found to be less than 0.1, which is within the acceptable level [151]. Local weights of the sub-factors were also computed using the same procedure. Table 7.6 shows the pair-wise comparison matrix for individual sub-factors. Table 7.7 shows the resulted normalised local weights for the individual sub-factors; performance expectancy (0.322), information security expectancy (0.453), effort expectancy (0.163) and social influence (0.062), with the value of consistency check was 0.026 $<$ 0.1. Table 7.8 shows the pair-wise comparison matrix for the technology sub-factors. Table 7.9 shows the resulted local weights for the technology sub-factors; software quality (0.364), service quality (0.153) and information quality (0.482), with the value of consistency of 0.075 $<$ 0.1. Table 7.10 shows the pair-wise comparison matrix for the organization sub-factors. Table 7.11 which shows the resulted normalised local weights for the organizational sub-factors; facilitating condition (0.693) and management support (0.307). A consistency check was done for all the normalised matrices and was found to be less than 0.1, which is within the acceptable level [151]. Once local weights were obtained for each of the factors and sub-factors, the global weights for each of the sub-factors were computed. These global weights were computed by multiplying the importance of each factor with those of the sub factors. The results are shown in Table 7.12.

Factor	Ind	Tech	Org
Individual	1.000	0.810	1.327
Technology	1.234	1.000	1.746
Organization	0.754	0.573	1.000

Table 7.4: The AHP PairWise Comparison Matrix of the Factors (Medical Software)

Factor	Ind	Tech	Org	Local Weight
Individual	0.335	0.340	0.326	0.334
Technology	0.413	0.420	0.429	0.421
Organization	0.252	0.240	0.246	0.246
Consistency Check	0.0009			

Table 7.5: The AHP normalised and Local Weight of Each factor (Medical Software)

Sub-Factor	PE	EE	SI	ISE
Performance Expectancy (PE)	1.000	2.078	6.083	0.598
Effort Expectancy (EE)	0.481	1.000	3.245	0.313
Social Influence (SI)	0.164	0.308	1.000	0.183
Information Security Expectancy (ISE)	1.672	3.200	5.473	1.000

Table 7.6: The AHP PairWise Comparison Matrix of the Individual Sub-Factors (Medical Software)

Factor	PE	EE	SI	ISE	Local Weight
Performance Expectancy (PE)	0.301	0.316	0.385	0.286	0.322
Effort Expectancy (EE)	0.145	0.152	0.205	0.149	0.163
Social Influence (SI)	0.050	0.047	0.063	0.087	0.062
Information Security Expectancy (ISE)	0.504	0.486	0.346	0.478	0.453
Consistency Checking	0.026				

Table 7.7: The AHP normalised and Local Weight of Each of the Individual Sub-factor (Medical Software)

Factor	SWQ	SERQ	IQ
Software Quality (SWQ)	1.000	3.187	0.566
Service Quality (SERQ)	0.314	1.000	0.410
Information Quality (IQ)	1.766	2.438	1.000

Table 7.8: The AHP PairWise Comparison Matrix of the Technology Sub-Factors (Medical Software)

Factor	SWQ	SERQ	IQ	Local Weight
Software Quality (SWQ)	0.325	0.481	0.286	0.364
Service Quality (SERQ)	0.102	0.151	0.208	0.153
Information Quality (IQ)	0.573	0.368	0.506	0.482
Consistency Check	0.075			

Table 7.9: The AHP normalised and Local Weight of Each the Technology Sub-factor (Medical Software)

Factor	FC	MS
Facilitating Condition (FC)	1.000	2.261
Management Support (MS)	0.442	1.000

Table 7.10: The AHP PairWise Comparison Matrix of the Organization Sub-Factors (Medical Software)

Factor	FC	MS	Local Weight
Facilitating Condition (FC)	0.693	0.693	0.693
Management Support (MS)	0.307	0.307	0.307
Consistency Check	0		

Table 7.11: The AHP normalised and Local Weight of Each the Organization Sub-factor (Medical Software)

Factor / Sub-Factor	Local Weights		Global Weight
Individual Factors		0.334	
Performance Expectancy (PE)	0.322		0.1076
Effort Expectancy (EE)	0.163		0.0544
Social Influence (SI)	0.062		0.0207
Information Security Expectancy (ISE)	0.453		0.1513
Technology Factors		0.421	
Software Quality (SWQ)	0.364		0.1532
Service Quality (SERQ)	0.153		0.0644
Information Quality (IQ)	0.482		0.2029
Organization Factors		0.246	
Facilitating Condition (FC)	0.693		0.1705
Management Support (MS)	0.307		0.0756

Table 7.12: The Global Weights of Each Sub-Factors (Medical Software) using AHP

7.6.3 Result - Fuzzy AHP: Chang's Method

The weights of the factors and sub-factors were re-calculated according to the Fuzzy Chang's methodology using the same data set. Using the fuzzy AHP approach, researcher established fuzzy pairwise comparison matrix as shown in Table 7.13. By applying formula (7.2-7.5) (described above in section 7.5.2), the fuzzy synthetic extent value of each factor, ind (i), tech (t) and org (o) were calculated , as follows:

Factor	Ind	Tech	Org
Ind	(1.000,1.000,1.000)	(0.5791,0.8102,1.4512)	(0.8942,1.3271,2.1309)
Tech	(0.6891,1.2343,1.7268)	(1.000,1.000,1.000)	(1.1498,1.7464,2.7519)
Org	(0.4693,0.7535,1.1183)	(0.3634,0.5726,0.8697)	(1.000,1.000,1.000)

Table 7.13: The Fuzzy AHP PairWise Comparison Matrix of the Medical Related Software Factors

$$\begin{aligned} S_i &= (2.473, 3.137, 4.582) \\ &\quad \otimes (1/13.049, 1/9.444, 1/7.145) \\ &= (0.190, 0.332, 0.641) \end{aligned}$$

$$\begin{aligned} S_t &= (2.839, 3.981, 5.479) \\ &\quad \otimes (1/13.049, 1/9.444, 1/7.145) \\ &= (0.218, 0.422, 0.767) \end{aligned}$$

$$\begin{aligned} S_o &= (1.833, 2.326, 2.988) \\ &\quad \otimes (1/13.049, 1/9.444, 1/7.145) \\ &= (0.140, 0.246, 0.418) \end{aligned}$$

Using these vectors, and formulae (7.6), (7.7) and (7.8) (described in section 7.5.2), the following values were calculated:

$$V(S_i \geq S_t) = 0.826, V(S_i \geq S_o) = 1.000,$$

$$V(S_t \geq S_i) = 1.000, V(S_t \geq S_o) = 1.000,$$

$$V(S_o \geq S_i) = 0.534, V(S_o \geq S_t) = 0.727.$$

Finally, by using formula (7.9) and (7.10) (described in section 7.5.2), the following weights were obtained:

$$D'(S_i) = V(S_i \geq S_t, S_o) = \min(0.826, 1.000) = 0.826$$

$$D'(S_t) = V(S_t \geq S_i, S_o) = \min(1.000, 1.000) = 1.000$$

$$D'(S_o) = V(S_o \geq S_i, S_t) = \min(0.534, 0.727) = 0.534$$

The resultant weight vectors for the medical software was W' = (0.826, 1.000, 0.534)$^{\mathrm{T}}$. After normalization, the normalised weight vector of each objective with respect to the individual, technology and organization factors was obtained as W_{goal}= (0.350, 0.424, 0.226). Using Chang's method, the results shows that technology factors scored the highest weight of 0.424, followed by individual factors (0.350) and finally organization factors (0.226).

Using the same steps as above, the weight of each of the sub-factors within these three broad categories were calculated. Within the individual factor, there were sub-factors of performance expectancy (PE), effort expectancy (EE), social influence (SI) and information security expectancy (SIE). The fuzzy pairwise comparison matrix for individual sub-factors is shown in Table 7.14.

Factor	PE	EE	SI	ISE
PE	(1.000,1.000,1.000)	(1.435,2.078,3.646)	(4.196,6.083,7.484)	(0.434,0.598,0.993)
EE	(0.274,0.481,0.697)	(1.000,1.000,1.000)	(2.117,3.245,4.592)	(0.246,0.313,0.475)
SI	(0.134,0.164,0.238)	(0.218,0.308,0.472)	(1.000,1.000,1.000)	(0.158,0.183,0.258)
ISE	(1.007,1.672,2.303)	(2.103,3.200,4.065)	(3.882,5.473,6.317)	(1.000,1.000,1.000)

Table 7.14: The Fuzzy AHP PairWise Comparison Matrix of the Individual Factor (Medical Software)

By applying formula (7.2 - 7.5) (described above in section 7.5.2), the fuzzy synthetic extent value of each sub-factor were calculated, as follows:

$$\begin{aligned} S_{PE} &= (7.064, 9.760, 13.122) \\ &\quad \otimes (1/35.540, 1/27.799, 1/20.204) \\ &= (0.199, 0.351, 0.649) \end{aligned}$$

$$S_{EE} = (3.637, 5.039, 6.764)$$
$$\otimes (1/35.540, 1/27.799, 1/20.204)$$
$$= (0.102, 0.181, 0.335)$$

$$S_{SI} = (1.510, 1.655, 1.968)$$
$$\otimes (1/35.540, 1/27.799, 1/20.204)$$
$$= (0.042, 0.060, 0.097)$$

$$S_{ISE} = (7.993, 11.345, 13.685)$$
$$\otimes (1/35.540, 1/27.799, 1/20.204)$$
$$= (0.225, 0.408, 0.677)$$

Using these vectors, and formulae (7.6), (7.7) and (7.8) (described in section 7.5.2), the following values were calculated:

$$V(S_{PE} \geq S_{EE}) = 1.000, V(S_{PE} \geq S_{SI}) = 1.000, V(S_{PE} \geq S_{ISE}) = 0.8816$$

$$V(S_{EE} \geq S_{PE}) = 0.4447, V(S_{EE} \geq S_{SI}) = 1.000, V(S_{EE} \geq S_{ISE}) = 0.3264$$

$$V(S_{SI} \geq S_{PE}) = 0.000, V(S_{SI} \geq S_{EE}) = 0.000, V(S_{SI} \geq S_{ISE}) = 0.000.$$

$$V(S_{ISE} \geq S_{PE}) = 1.000, V(S_{ISE} \geq S_{EE}) = 1.000, V(S_{ISE} \geq S_{SI}) = 1.000.$$

Finally, by using formula (7.9) and (7.10) (described in section 7.5.2), the following weights were obtained:

$$D'(S_{PE}) = V(S_{PE} \geq S_{EE}, S_{SI}, S_{ISE}) = \min(1.000, 1.000, 0.8816) = 0.8816$$

$$D'(S_{EE}) = V(S_{EE} \geq S_{pe}, S_{SI}, S_{ISE}) = \min(0.445, 1.000, 0.3264) = 0.3261$$

$$D'(S_{SI}) = V(S_{SI} \geq S_{pe}, S_{EE}, S_{ISE}) = \min(0.000, 0.000, 0.000) = 0.0000$$

$$D'(S_{ISE}) = V(S_{ISE} \geq S_{pe}, S_{EE}, S_{SI}) = \min(1.000, 1.000, 1.000) = 1.0000$$

The resultant weight vector for these individual sub-factors was W' = (0.8816, 0.3264, 0.0000, 1.0000)^{T}. After normalization, the normalised weight vector for each objective with respect to the performance expectancy (PE), effort expectancy (EE), social influence (SI) and information security expectancy was obtained as W_{goal}= (0.3993, 0.1478, 0.000, 0.4529).

Within the technology category, there were sub-factors of software quality (SWQ), service quality (SERQ) and information quality (IQ). The fuzzy pairwise comparison matrix for the technology sub-factors is shown in Table 7.15.

Factor	SWQ	SERQ	IQ
SWQ	(1.000,1.000,1.000)	(2.084,3.1871,4.8958)	(0.4610,0.5662,1.0016)
SERQ	(0.2043,0.3138,0.4799)	(1.000,1.000,1.000)	(0.3212,0.4101,0.7240)
IQ	(0.9984,1.7662,2.1692)	(1.3812,2.4384,3.1133)	(1.000,1.000,1.000)

Table 7.15: The Fuzzy AHP PairWise Comparison Matrix of the Technology Sub-Factors (Medical Software)

By applying formula (7.2 - 7.5) (described above in section 7.5.2), the fuzzy synthetic extent value of each sub-factor were calculated, as follows:

$$\begin{aligned} S_{SWQ} &= (3.5448, 4.7533, 6.8974) \\ &\quad \otimes (1/15.384, 1/11.682, 1/8.450) \\ &= (0.2304, 0.4070, 0.8163) \end{aligned}$$

$$\begin{aligned} S_{SERQ} &= (1.5255, 1.7239, 2.2039) \\ &\quad \otimes (1/15.384, 1/11.682, 1/8.450) \\ &= (0.0992, 0.1476, 0.2608) \end{aligned}$$

$$\begin{aligned} S_{IQ} &= (3.3796, 5.2046, 6.2825) \\ &\quad \otimes (1/15.384, 1/11.682, 1/8.450) \\ &= (0.2197, 0.4455, 0.7435) \end{aligned}$$

Using these vectors, and formula (7.6), (7.7) and (7.8) (described in section 7.5.2), the following values were calculated:

$$V(S_{SWQ} \geq S_{SERQ}) = 1.000, V(S_{SWQ} \geq S_{IQ}) = 0.9392,$$

$$V(S_{SERQ} \geq S_{SWQ}) = 0.1050, V(S_{SERQ} \geq S_{IQ}) = 0.1211,$$

$$V(S_{IQ} \geq S_{SWQ}) = 1.000, V(S_{IQ} \geq S_{SERQ}) = 1.000$$

Finally, by using formula (7.9) and (7.10) (described in section 7.5.2), the following weights were obtained:

$$D'(S_{SWQ}) = V(S_{SWQ} \geq S_{SERQ}, S_{IQ}) = \min(1.000, 0.9392) = 0.9392$$

$$D'(S_{SERQ}) = V(S_{SERQ} \geq S_{SWQ}, S_{IQ}) = \min(0.1050, 0.1211) = 0.1050$$

$$D'(S_{IQ}) = V(S_{IQ} \geq S_{SWQ}, S_{SERQ}) = \min(1.000, 1.000) = 1.000$$

The resultant weight vector for these technology sub-factors was W' = (0.9392, 0.1049, 1.000)^T. After normalization, the normalised weights for each technology factors, software quality (SWQ), service quality (SERQ) and information quality (IQ) was obtained as W_{goal}= (0.4595, 0.0513, 0.4892).

Within the organization category, there were sub-factors of facilitating condition (FC) and management support (MS). The fuzzy pairwise comparison matrix for the organization sub-factors is shown in Table 7.16.

Factor	FC	MS
FC	(1.000,1.000,1.000)	(1.403,2.261,3.647)
MS	(0.274,0.442,0.713)	(1.000,1.000,1.000)

Table 7.16: The Fuzzy AHP PairWise Comparison Matrix of the Organization Sub-Factors (Medical Software)

By applying formula (7.2 - 7.5) (described above in section 7.5.2), the fuzzy synthetic extent value of each sub-factor were calculated, as follows:

$$\begin{aligned} S_{FC} &= (2.403, 3.261, 4.646) \\ &\quad \otimes (1/6.360, 1/4.704, 1/3.677) \\ &= (0.3778, 0.6933, 1.2638) \end{aligned}$$

$$\begin{aligned} S_{MS} &= (1.274, 1.442, 1.713) \\ &\quad \otimes (1/6.360, 1/4.704, 1/3.677) \\ &= (0.2003, 0.3066, 0.4659) \end{aligned}$$

Using these vectors, and formulae (7.6), (7.7) and (7.8) (described in section 7.5.2), the following values were calculated:

$$V(S_{FC} \geq S_{MS}) = 1.0000$$

$$V(S_{MS} \geq S_{FC}) = 0.1301$$

Finally, by using formulae (7.9) and (7.10) (described in section 7.5.2), the following weights were obtained:

$$D'(S_{FC}) = V(S_{FC} \geq S_{MS}) = \min(1.000) = 1.000$$

$$D'(S_{MS}) = V(S_{MS} \geq S_{FC}) = \min(0.1301) = 0.1301$$

The resultant weight vector for these organization sub-factors was $W' = (1.000, 0.1301)^T$. After normalization, the normalised weight vector for each objective with respect to the facilitating condition and management support were obtained as W_{goal}= (0.845, 0.1155).

Once the local weights for each factor and sub-factors, the next step is to calculate the global weights for each sub-factors. This is performed by multiplying the weight of each factor with those of the sub-factors. The results are shown in Table 7.17.

7.6.4 Result - Fuzzy AHP α and λ Method

Using the same data as shown in Table 7.13, the researcher applied the alternative FAHP method to compute the weights for each of the decision elements. Once data had been collected and assigned its equivalent fuzzy triangular number (step 1), the fuzzy pair-wise comparison matrix was established (step 2), shown in table 7.13. The following steps show how the weights were computed for each of the factor and sub-factors.

Step 3 : Defuzzification

Defuzzification is performed to obtain the aggregate pair-wise comparison matrix, by

Factor/ Sub-Factor	**Local Weight**		**Global Weight**
Individual Factor		0.350	
PE	0.399		0.140
EE	0.148		0.052
SI	0.000		0.000
ISE	0.453		0.159
Technology Factor		0.424	
SWQ	0.459		0.195
SERQ	0.051		0.022
IQ	0.489		0.207
Organization Factor		0.226	
FC	0.885		0.200
MS	0.115		0.026

Table 7.17: The Global Weights of the Sub-Factors using Fuzzy AHP Chang's Method (Medical Software)

using formulae described in section 7.5.3 above. The calculations were performed as follows:

$$L_{12}^{0.5} = (0.8102 - 0.5791) * 0.5 + 0.5791 = 0.6947$$

$$U_{12}^{0.5} = 1.4512 - (1.4512 - 0.8102) * 0.5 = 1.1307$$

$$(a_{12}^{0.5})^{0.5} = (0.5 * 6947 + (1 - 0.5) * 1.1307) = 0.9127$$

$$L_{13}^{0.5} = (1.3271 - 0.8942) * 0.5 + 0.8942 = 1.1107$$

$$U_{13}^{0.5} = 2.1309 - (2.1309 - 1.3271) * 0.5 = 1.7290$$

$$(a_{13}^{0.5})^{0.5} = (0.5 * 1.1107 + (1 - 0.5) * 1.7290) = 1.4198$$

$$L_{23}^{0.5} = (1.7464 - 1.1498) * 0.5 + 1.1498 = 1.4481$$

$$U_{23}^{0.5} = 2.7519 - (2.7519 - 1.7464) * 0.5 = 2.2492$$

$$(a_{23}^{0.5})^{0.5} = (0.5 * 1.4481 + (1 - 0.5) * 2.2492) = 1.8486$$

The resulted aggregate pair-wise comparison matrix of each of the factor is shown in Table 7.18.

Factor	Ind	Tech	Org
Ind	1.000	0.9217	1.4198
Tech	1.0957	1.000	1.8486
Org	0.7043	0.5409	1.000

Table 7.18: The Aggregate Pair Wise Comparison Matrix of the Factor (Fuzzy AHP α and λ Method)

Factor	Weight
Ind	0.3539
Tech	0.4107
Org	0.2354
Consistency Check	0.001697

Table 7.19: The Eigenvectors for Each Factor (Medical Software)

Step 4: Eigenvectors

Using this matrix shown in Table 7.18, the eigenvectors for the factors using formula (7.18) and (7.19) were calculated .Table 7.19 summarises the results of eigenvectors for each factor. The results show that this approach produced slightly different rankings of the factors compared to classical AHP and Chang's extent analysis method. This approach suggested the individual factor as the most influential factor of user acceptance followed by the technology factor and lastly by the organization factor. The same procedures shown above are used to calculate the weights of the sub-factors of each factor. The resultant local weights and global weights of sub-factors of each factor are presented in table 7.20.

Factor	Local Weight	Global Weight
Individual Factor (0.3539)		
Performance Expectancy (PE)	0.3395	0.120
Effort Expectancy (EE)	0.1647	0.058
Social Influence (SI)	0.0635	0.0225
Information Security Expectancy (ISE)	0.4323	0.153
Consistency Check	0.025	
Technology Factor(0.4107)		
Software Quality (SWQ)	0.3912	0.161
Service Quality (SERQ)	0.1601	0.066
Information Quality (IQ)	0.4487	0.184
Consistency Check	0.0847	
Organizational Factor(0.2354)		
Facilitating Condition (FC)	0.7053	0.166
Management Support (MS)	0.2947	0.069
Consistency Check		

Table 7.20: The Local Weights and Global Weights of Sub-factor using Fuzzy AHP α and λ Method (Medical Software)

7.6.5 Comparison Between Different Methods - Medical Software

Table 7.21 shows the global weights of each sub-factor using AHP, Fuzzy AHP Chang's Method and Fuzzy α and λ . Global weights were calculated by multiplying the local weights of the factor with the local weights of the sub-factors. Based on these global weights, the ranking of the sub-factors were performed. Table 7.22 shows the ranking comparison using various approaches for the acceptance of medically related software. Reviewing the ranks across all the dimensions in this table, all methods resulted in similar ranking of the first 5 sub-factors which could influence user acceptance of medical related software. Further, all methods assigned the lowest weights for the Social Influence factor which indicates that Social Influence factor does not play a role in influencing user intention to use the software.

The results also show that Fuzzy Changs' method produced slightly different results for the 6^{th}, 7^{th} and 8^{th} factors. On the other hand, the weights computed by both AHP and Fuzzy α and λ methods resulted in exactly similar ranking of the sub-factors. All methods assigned highest weight for information quality (IQ). This indicates that the quality of the information produced by the software was a crucial aspect for medically related software. As medical software deals with lots of confidential and highly sensitive information, it is important that software developers produce software that meet this criteria. The first three most important factors that influence acceptance of medically related software are information quality (IQ), facilitating condition (FC) and software quality (SWQ). Among these two factors, IQ and SWQ were both from within the technology factor. This also indicates that the technology factor plays a significant role in user intention to use software.

Sub-factors	**Global Weights**		
	AHP	**FAHP Chang**	**FAHP α and λ**
PE	0.108	0.140	0.120
EE	0.055	0.052	0.058
SI	0.021	0.000	0.023
ISE	0.151	0.159	0.153
SWQ	0.153	0.195	0.161
SERQ	0.065	0.022	0.066
IQ	0.203	0.207	0.184
FC	0.171	0.200	0.166
MS	0.075	0.026	0.069

Table 7.21: Global Weight for Each Sub-Factor Using AHP, Fuzzy AHP and Fuzzy α and λ Methods (Medical Software)

Rank	AHP	FAHP-Chang	FAHP-αλ
1	IQ	IQ	IQ
2	FC	FC	FC
3	SWQ	SWQ	SWQ
4	ISE	ISE	ISE
5	PE	PE	PE
6	MS	EE	MS
7	SERQ	MS	SERQ
8	EE	SERQ	EE
9	SI	SI	SI

Table 7.22: Ranking of the Sub-Factors Using Various Approaches (Medical Software)

7.7 Data Analysis and Results - Research Software

7.7.1 Response Rate and Sample Characteristics

An on-line questionnaire was distributed through the mailing list of research students in the University of Nottingham from December 2010 until March 2011. 62 users responded to the questionnaire. Among these, 35 were male and 27 were female. 39 of the respondents were within 20-29 years old, 16 were between 30-39 years old, two were less than 20 years old and five were above 40 years old. In terms of respondents' status or role, 60 of them were postgraduate student, 1 was a research assistant and 1 was in the 'other' category.

Among the software indicated by the students as used in research work were NVivo, SPSS, R, Matlab, Endnote, STATA, LabSpec, Weasel, and GenStat. Respondents were asked to indicate the extent to which they felt factors influenced their acceptance of the research software through the pair-wise comparison method using linguistic variables (ranging from 1 = equally important to 9 = Absolutely More Important), as described in Table 4.1.

7.7.2 Result - Classical AHP Approach

Table 7.23 shows the AHP pairwise comparison matrix of factors for the 62 respondents. By applying steps 3 and 4 described in section 7.5.1, the normalised values were computed followed by local weights for each of the factors as shown in Table 7.24. Using the AHP method, the result shows that the technology factor was the most influential factor in students' acceptance of the research related software, followed by the individual factor and finally the organisation factor. Also consistency check was done for all the normalised matrices and was found to be less than 0.1, which is within the acceptable level [151].

Local weights of the sub-factors are also determined using the same procedures. Table 7.25 shows the pair-wise comparison matrix for the individual sub-factors. Table 7.26 shows the normalised local weights for the individual sub-factors; performance expectancy (0.537), effort expectancy (0.231), social influence (0.100) and information security expectancy (0.132) with consistency check value of 0.017.

Factor	Ind	Tech	Org
Individual	1.000	0.980	3.473
Technology	1.020	1.000	3.439
Organization	0.288	0.291	1.000

Table 7.23: The AHP Pair-Wise Comparison Matrix of the Factors (Research Software)

Factor	Ind	Tech	Org	Local Weight
Individual	0.433	0.432	0.439	0.435
Technology	0.442	0.440	0.435	0.439
Organization	0.125	0.128	0.126	0.126
Consistency Check	0.00011			

Table 7.24: The AHP normalised and Local Weight of Each factor (Research Software)

Factor	PE	EE	SI	ISE
Performance Expectancy (PE)	1.000	2.888	4.564	3.924
Effort Expectancy (EE)	0.346	1.000	2.926	1.659
Social Influence (SI)	0.219	0.342	1.000	0.797
Information Security Expectancy (ISE)	0.255	0.603	1.000	1.000

Table 7.25: The AHP PairWise Comparison Matrix of the Individual Sub-Factors (Research Software)

Factor	PE	EE	SI	ISE	Local Weight
Performance Expectancy (PE)	0.549	0.598	0.468	0.532	0.537
Effort Expectancy (EE)	0.190	0.207	0.300	0.225	0.231
Social Influence (SI)	0.120	0.071	0.103	0.108	0.100
Information Security Expectancy (ISE)	0.140	0.125	0.129	0.135	0.132
Consistency Checking	0.017				

Table 7.26: The AHP normalised and Local Weight of Each Individual Sub-factors (Research Software)

Table 7.27 shows the pair-wise comparison matrix for the technology sub-factors. The local weights computed for technology sub factor and results are shown in table 7.28; software quality (0.400), service quality (0.104), information quality (0.495) with consistency check value of 0.015 which is < 0.1.

Table 7.29 shows the pair-wise comparison matrix for the organization sub-factors. Table 7.30 shows the normalised local weights for the organizational sub-factors; facilitating condition (0.702) and management support (0.298). Once the local weights for each of the factors and sub-factors were computed, the global weights were calculated.

Factor	SWQ	SERQ	IQ
Software Quality (SWQ)	1.000	4.341	0.717
Service Quality (SERQ)	0.230	1.000	0.236
Information Quality (IQ)	1.395	4.239	1.000

Table 7.27: The AHP PairWise Comparison Matrix of the Technology Sub-Factors (Research Software

Factor	SWQ	SERQ	IQ	Local Weight
Software Quality (SWQ)	0.381	0.453	0.367	0.400
Service Quality (SERQ)	0.088	0.104	0.121	0.104
Information Quality (IQ)	0.531	0.442	0.512	0.495
Consistency Check	0.015			

Table 7.28: The AHP normalised and Local Weight of Each the Technology Sub-factor (Research Software)

Factor	FC	MS
Facilitating Condition (FC)	1.000	2.356
Management Support (MS)	0.424	1.000

Table 7.29: The AHP PairWise Comparison Matrix of the Organization Sub-Factors (Research Software)

Factor	FC	MS	Local Weight
Facilitating Condition (FC)	0.702	0.702	0.702
Management Support (MS)	0.298	0.298	0.298
Consistency Check	0		

Table 7.30: The AHP normalised and Local Weight of Each the Organization Sub-facto (Research Software)

These global weights are computed by multiplying the importance of each factor with those of the sub factors. The results are shown in Table 7.31. The weights obtained shows that performance expectancy is the most influential factor of user acceptance of research software and social influence is the least influential factor of user acceptance.

Factor / Sub-Factor	Local Weights		Global Weight
Individual Factors		0.435	
Performance Expectancy (PE)	0.537		0.2336
Effort Expectancy (EE)	0.231		0.1005
Social Influence (SI)	0.100		0.0435
Information Security Expectancy (ISE)	0.132		0.0574
Technology Factors		0.439	
Software Quality (SWQ)	0.400		0.1756
Service Quality (SERQ)	0.104		0.0457
Information Quality (IQ)	0.495		0.2173
Organization Factors		0.126	
Facilitating Condition (FC)	0.702		0.0885
Management Support (MS)	0.298		0.0376

Table 7.31: The Global Weights of Each Sub-Factors (Research Software)

7.7.3 Result - Fuzzy AHP: Chang's Method

Using the fuzzy AHP Chang's method, the fuzzy pair-wise comparison matrix are first established as shown in Table 7.32. By applying formula (7.2 - 7.5) (described in section 7.5.2), the fuzzy synthetic extent value of each factor, individual (i), technology (t) and organization (o) are calculated, as follows:

Factor	Ind	Tech	Org
Ind	(1.000,1.000,1.000)	(0.636,0.980,1.548)	(2.244,3.473,4.892)
Tech	(0.646,1.020,1.573)	(1.000,1.000,1.000)	(2.274,3.439,4.952)
Org	(0.204,0.288,0.446)	(0.202,0.291,0.440)	(1.000,1.000,1.000)

Table 7.32: The Fuzzy AHP PairWise Comparison Matrix of the Factors (Research Software)

$$S_i = (3.879, 5.453, 7.439) \otimes (1/16.849, 1/12.491, 1/9.206)$$
$$= (0.230, 0.437, 0.808)$$

$$S_t = (3.920, 5.459, 7.525) \otimes (1/16.849, 1/12.491, 1/9.206)$$
$$= (0.233, 0.437, 0.817)$$

$$S_o = (1.406, 1.579, 1.886) \otimes (1/16.849, 1/12.491, 1/9.206)$$
$$= (0.084, 0.126, 0.205)$$

Using these vectors, and formulae (7.6) and formula (7.7), the following values are calculated:

$$V(S_i \geq S_t) = 0.9809, V(S_i \geq S_o) = 1.000,$$

$$V(S_t \geq S_i) = 1.000, V(S_t \geq S_o) = 1.000,$$

$$V(S_o \geq S_i) = 0.000, V(S_o \geq S_t) = 0.000.$$

Finally, by using formula (7.10) the following weights are obtained:

$$D'(S_i) = V(S_i \geq S_t, S_o) = min(0.981, 1.000) = 0.981$$

$$D'(S_t) = V(S_t \geq S_i, S_o) = min(1.000, 1.000) = 1.000$$

$$D'(S_o) = V(S_o \geq S_i, S_t) = min(0.000, 1.000) = 0.000$$

The resultant weight vector is $W' = (0.981,1.000,0.000)^{T}$. After normalisation, the normalised weight vector of each objective with respect to the ind, tech and org factors was obtained as W_{goal}= (0.495, 0.505, 0.000). Using Chang's method, the results show that technology factors scored the highest weight of 0.505, followed by individual factors (0.4095) and finally organisation factors (0.000). This result suggests the same ranking of the factors which influence user acceptance of medical related software as suggested by the classical AHP approach (shown in section 7.7.2).

Using the same steps as above, the weight of each of the sub-factors within these three broad categories were calculated. Within the individual factor, there were sub-factors of performance expectancy (PE), effort expectancy (EE), social influence (SI) and information security expectancy (SIE). The fuzzy pairwise comparison matrix for individual sub-factors is shown in Table 7.33.

Factor	**PE**	**EE**	**SI**	**SI**
PE	(1.000,1.000,1.000)	(1.816,2.888,4.410)	(3.118,4.564,5.789)	(2.624,3.924,5.344)
EE	(0.227,0.346,0.551)	(1.000,1.000,1.000)	(2.037,2.926,4.067)	(1.125,1.659,2.427)
SI	(0.173,0.219,0.321)	(0.246,0.342,0.491)	(1.000,1.000,1.000)	(0.557,0.797,1.215)
ISE	(0.187,0.255,0.381)	(0.412,0.603,0.889)	(0.823,1.254,1.794)	(1.000,1.000,1.000)

Table 7.33: The Fuzzy AHP PairWise Comparison Matrix of the Individual Factor (Research Software)

By applying formula (7.2 - 7.5) (described above in section 7.5.2), the fuzzy synthetic extent value of each sub-factor were calculated, as follows:

$$\begin{aligned} S_{PE} &= (8.558, 12.376, 16.543) \\ &\quad \otimes (1/31.678, 1/23.777, 1/17.345) \\ &= (0.270, 0.520, 0.954) \end{aligned}$$

$$\begin{aligned} S_{EE} &= (4.388, 5.931, 8.044) \\ &\quad \otimes (1/31.678, 1/23.777, 1/17.345) \\ &= (0.139, 0.249, 0.464) \end{aligned}$$

$$\begin{aligned} S_{SI} &= (1.976, 2.358, 3.027) \\ &\quad \otimes (1/31.678, 1/23.777, 1/17.345) \\ &= (0.062, 0.099, 0.174) \end{aligned}$$

$$S_{ISE} = (2.422, 3.112, 4.064) \otimes (1/31.678, 1/23.777, 1/17.345) = (0.076, 0.131, 0.234)$$

Using these vectors, and formulae (7.6), (7.7) and (7.8) (described in section 7.5.2), the following values are calculated:

$$V(S_{PE} \geq S_{EE}) = 1.000, V(S_{PE} \geq S_{SI}) = 1.000, V(S_{PE} \geq S_{ISE}) = 1.000$$

$$V(S_{EE} \geq S_{PE}) = 0.417, V(S_{EE} \geq S_{SI}) = 1.000, V(S_{EE} \geq S_{ISE}) = 1.000$$

$$V(S_{SI} \geq S_{PE}) = 0.000, V(S_{SI} \geq S_{EE}) = 0.1931, V(S_{SI} \geq S_{ISE}) = 0.7556$$

$$V(S_{ISE} \geq S_{PE}) = 0.000, V(S_{ISE} \geq S_{EE}) = 0.4469, V(S_{ISE} \geq S_{SI}) = 1.000$$

Finally, by using formulae (7.9) and (7.10) (described in section 7.5.2), the following weights were obtained:

$$D'(S_{PE}) = V(S_{PE} \geq S_{EE}, S_{SI}, S_{ISE}) = \min(1.000, 1.000, 1.000) = 1.000$$

$$D'(S_{EE}) = V(S_{EE} \geq S_{PE}, S_{SI}, S_{ISE}) = \min(0.417, 1.000, 1.000) = 0.417$$

$$D'(S_{SI}) = V(S_{SI} \geq S_{PE}, S_{EE}, S_{ISE}) = \min(0.000, 0.1931, 0.7556) = 0.000$$

$$D'(S_{ISE}) = V(S_{ISE} \geq S_{PE}, S_{EE}, S_{SI}) = \min(0.000, 0.4469, 1.000) = 0.0000$$

The resultant weight vector for these individual sub-factors was W' = (1.000, 0.417, 0.000, 0.000)^{T}. After normalization, the normalised weight vector for each sub-factor, performance expectancy (PE), effort expectancy (EE), social influence (SI) and information security expectancy (ISE) was obtained as W_{goal}= (0.7059, 0.2941, 0.000, 0.000).

Within technology factor, there were sub-factors of software quality (SWQ), service quality (SERQ) and information quality (IQ). Within the organization factor, there were sub-factors of facilitating condition (FC) and management support (MS). The fuzzy pairwise comparison matrix for technology sub-factors is shown in Table 7.34.

By applying formula (7.2 - 7.5) (described above in section 7.5.2), the fuzzy synthetic extent value of each sub-factor were calculated, as follows:

Factor	SWQ	SERQ	IQ
SWQ	(1.000,1.000,1.000)	(3.026,4.341,5.798)	(0.534,0.717,1.274)
SERQ	(0.172,0.230,0.330)	(1.000,1.000,1.000)	(0.183,0.236,0.358)
IQ	(0.785,1.395,1.873)	(2.793,4.237,5.464)	(1.000,1.000,1.000)

Table 7.34: The Fuzzy AHP PairWise Comparison Matrix of the Technology Sub-Factors (Research Software)

$$S_{SWQ} = (4.560, 6.058, 8.072) \otimes (1/18.098, 1/14.156, 1/10.493) = (0.252, 0.428, 0.769)$$

$$S_{SERQ} = (1.355, 1.466, 1.688) \otimes (1/18.098, 1/14.156, 1/10.493) = (0.075, 0.104, 0.161)$$

$$S_{IQ} = (4.578, 6.633, 8.337) \otimes (1/18.098, 1/14.156, 1/10.493) = (0.253, 0.469, 0.795)$$

Using these vectors, and formulae (7.6), (7.7) and (7.8) (described in section 7.5.2), the following values were calculated:

$$V(S_{SWQ} \geq S_{SERQ}) = 1.000, V(S_{SWQ} \geq S_{IQ}) = 0.926,$$

$$V(S_{SERQ} \geq S_{SWQ}) = 0.000, V(S_{SERQ} \geq S_{IQ}) = 0.000,$$

$$V(S_{IQ} \geq S_{SWQ}) = 1.000, V(S_{IQ} \geq S_{SERQ}) = 1.000$$

Finally, by using formulae (7.9) and (7.10) (described in section 7.5.2), the following weights were obtained:

$$D'(S_{SWQ}) = V(S_{SWQ} \geq S_{SERQ}, S_{IQ}) = \min(1.000, 0.926) = 0.926$$

$$D'(S_{SERQ}) = V(S_{SERQ} \geq S_{SWQ}, S_{IQ}) = \min(0.000, 0.000) = 0.000$$

$$D'(S_{IQ}) = V(S_{IQ} \geq S_{SWQ}, S_{SERQ}) = \min(1.000, 1.000) = 1.000$$

The resultant weight vector for these technology sub-factors was W' = (0.926, 0.000, 1.000)^T. After normalization, the normalised weight vector for each sub-factor, software quality (SWQ), service quality (SERQ) and information quality (IQ) was obtained as W_{goal}= (0.481, 0.000, 0.519).

Within the organization factor, there were sub-factors of facilitating condition (FC) and management support (MS). The fuzzy pairwise comparison matrix for organization sub-factors is shown in Table 7.35.

Factor	FC	MS
FC	(1.000,1.000,1.000)	(1.492,2.356,3.761)
MS	(0.266,0.424,0.670)	(1.000,1.000,1.000)

Table 7.35: The Fuzzy AHP PairWise Comparison Matrix of the Organization Sub-Factors (Research Software)

By applying formula (7.2 - 7.5) (described above in section 7.5.2), the fuzzy synthetic extent value of each sub-factor were calculated, as follows:

$$
\begin{aligned}
S_{FC} &= (2.492, 3.356, 4.761) \\
&\qquad \otimes (1/6.431, 1/4.781, 1/3.758) \\
&= (0.387, 0.702, 1.267)
\end{aligned}
$$

$$
\begin{aligned}
S_{MS} &= (1.266, 1.424, 1.670) \\
&\qquad \otimes (1/6.431, 1/4.781, 1/3.758) \\
&= (0.197, 0.298, 0.445)
\end{aligned}
$$

Using these vectors, and formulae (7.6), (7.7) and (7.8) (described in section 7.5.2), the following values were calculated:

$$V(S_{FC} \geq S_{MS}) = 1.0000$$

$$V(S_{MS} \geq S_{FC}) = 0.1238$$

Finally, by using formulae (7.9) and (7.10) (described in section 7.5.2), the following weights were obtained:

Factor/ Sub-Factor	Local Weight	Global Weight
Individual Factor	0.4952	
PE	0.7059	0.350
EE	0.2941	0.146
SI	0.000	0.000
ISE	0.000	0.000
Technology Factor	0.5048	
SWQ	0.4810	0.243
SERQ	0.0000	0.000
IQ	0.5190	0.262
Organization Factor	0.000	
FC	0.8889	0.000
MS	0.1102	0.000

Table 7.36: The Global Weights of the Sub-Factors using Fuzzy AHP Method (Research Software)

$$D'(S_{FC}) = V(S_{FC} \geq S_{MS}) = \min(1.000) = 1.000$$

$$D'(S_{MS}) = V(S_{MS} \geq S_{FC}) = \min(0.1238) = 0.1238$$

The resultant weight vector for these organization sub-factors was $W' = (1.000, 0.1238)^{\mathrm{T}}$. After normalization, the normalised weight vector for each objective with respect to the facilitating condition and management support was obtained as W_{goal}= (0.8898, 0.1102).

Once the local weights for each factor and sub-factors, the next step is to calculate the global weights for each sub-factors. This is performed by multiplying the weight of each factor with those of the sub-factors. The results are shown in Table 7.36.

7.7.4 Results - Fuzzy AHP α and λ Method

Using the same data as shown in Table 7.13, the researcher applied the alternative FAHP method to compute the weights for each of the decision elements. Once the data was collected and assigned its equivalent fuzzy triangular number (step 1), the fuzzy pair-wise comparison matrix was established (step 2), as shown in table 7.13. The following steps show how the weights are computed for each of the factor and sub-factors.

Step 3 : Defuzzification

Defuzzification is performed to obtain the aggregate pair-wise comparison matrix, using formula (7.17) described in section 7.5.3 above. The calculation performed as follows:

$$L_{12}^{0.5} = (0.980 - 0.636) * 0.5 + 0.636 = 0.808$$

$$U_{12}^{0.5} = 1.548 - (1.548 - 0.980) * 0.5 = 1.264$$

$$(a_{12}^{0.5})^{0.5} = (0.5 * 0.808 + (1 - 0.5) * 1.264) = 1.036$$

$$L_{13}^{0.5} = (3.473 - 2.244) * 0.5 + 2.244 = 2.8581$$

$$U_{13}^{0.5} = 4.892 - (4.892 - 3.473) * 0.5 = 4.182$$

$$(a_{13}^{0.5})^{0.5} = (0.5 * 2/8581 + (1 - 0.5) * 4.182) = 3.520$$

$$L_{23}^{0.5} = (3.439 - 2.274) * 0.5 + 2.274 = 2.856$$

$$U_{23}^{0.5} = 4.952 - (4.952 - 3.439) * 0.5 = 4.195$$

$$(a_{23}^{0.5})^{0.5} = (0.5 * 2.856 + (1 - 0.5) * 4.195) = 3.529$$

The resultant aggregate pair-wise comparison matrix of each of the factor is shown in Table 7.37.

Factor	Ind	Tech	Org
Ind	1.000	1.036	3.520
Tech	0.965	1.000	3.529
Org	0.284	0.284	1.000

Table 7.37: The Aggregate Pair Wise Comparison Matrix of the Factor (Fuzzy AHP α and λ Method)

Factor	Weight
Ind	0.443
Tech	0.433
Org	0.124
Consistency Check	0.00026

Table 7.38: The Eigenvectors for Each Factor (Research Software)

Factor	Local Weight	Global Weight
Individual Factor (0.443)		
Performance Expectancy (PE)	0.5388	0.239
Effort Expectancy (EE)	0.2312	0.102
Social Influence (SI)	0.1015	0.045
Information Security Expectancy (ISE)	0.1285	0.057
Consistency Check	0.022072	
Technology Factor (0.433)		
Software Quality (SWQ)	0.4227	0.183
Service Quality (SERQ)	0.1076	0.047
Information Quality (IQ)	0.4697	0.203
Consistency Check	0.011617	
Organizational Factor (0.124)		
Facilitating Condition (FC)	0.7136	0.089
Management Support (MS)	0.2864	0.036
Consistency Check		

Table 7.39: The Eigenvectors for Each Factors' Sub-Factor and Consistency Check (Fuzzy AHP α and λ Method)

Step 4: Eigenvectors

Using this matrix, the eigenvectors for the factors using formula (7.18) and (7.19) were calculated. Table 7.38 summarises the results of eigenvectors for each factor.

These results show that this method produced slightly different rankings of the factors compared to classical AHP and Chang's extent analysis method. This approach suggested the individual factor as the most influential factor of user acceptance followed by the technology factor and lastly by the organization factor.

The same procedures shown above are used to calculate the weights of the sub-factors of each factor. The resultant local weights of sub-factors of each factor are presented in table 7.39. A consistency check was done for all the normalised matrices and was found to be less than 0.1, which is within the acceptable level [151].

7.7.5 A Conventional Average Weight Method

In order to compute the weights of the factors and sub-factors directly (without an MCDA approach), the respondents were asked to indicate the level of importance of each factor and sub-factor in a scale of ‘not important’ to ‘extremely important’. In order to calculate the average of each factor and sub-factor, a value of 1 for ‘not important’ up to 9 for ‘extremely important’ were assigned. The total of each factor were summed and were divided with the number of respondents to obtain average weight of each factor as well as sub-factors. Table 7.40 shows the average weight of the sub-factors. This method produced the slightly different ranking compared to the pair-wise comparison methods. The most influential factors was performance expectancy, followed by software quality, information quality, effort expectancy, facilitating condition, information security expectancy, service quality, management support and finally social influence factor.

Sub-Factor	**Average Weight**
PE	7.436
EE	6.194
SI	3.710
ISE	4.484
SWQ	7.032
SERQ	4.452
IQ	6.903
FC	4.839
MS	4.097

Table 7.40: The Average Weights for the Sub-factor (Research Software)

7.7.6 Comparison Between Different Methods - Research Software

Table 7.41 presents the global weights the sub-factors using the approaches previously discussed. Table 7.42 shows the ranking comparison using various approaches. As the results show all these methods produced the same ranking of user acceptance factors. Although, the Fuzzy AHP Changs’ Method produces 0.000 value for five of the factors it does not effect the results on the four of sub-factors. In terms of research related software the sub-factor performance expectancy is the most influential factor of user acceptance. The social influence sub-factor is shown to not play any role in influencing user acceptance of research software.

Reviewing the ranks across all the dimensions in this table, the sub-factors performance expectancy (PE), information quality (IQ) and software quality (SWQ) were the first three most influential factors of user acceptance of research related software. This implies that if the users (i.e. students) believe that using the software will increase and improve their research related work, they will be more likely to use the software. Except for the results obtained using the average weight method (shown in section 7.7.5) , all other methods ranked management support as the lowest sub-factor in influencing user acceptance of the software technology. As long as the users believe that particular software was easy to use and will improve their research related work, management support appears to have very little influence in their acceptance.

Sub-factors	**Global Weights**		
	AHP	**FAHP Chang**	**FAHP α and λ**
PE	0.233	0.350	0.239
EE	0.100	0.146	0.102
SI	0.044	0.000	0.045
ISE	0.058	0.000	0.057
SWQ	0.176	0.243	0.183
SERQ	0.046	0.000	0.046
IQ	0.218	0.262	0.204
FC	0.089	0.000	0.089
MS	0.038	0.000	0.036

Table 7.41: Local Weights and Global Weight for Each of the Sub-Factor Using Various Approaches (Research Software)

Rank	AHP	FAHP-Chang	FAHP-αλ
1	PE	PE	PE
2	IQ	IQ	IQ
3	SWQ	SWQ	SWQ
4	EE	EE	EE
5	FC	FC	FC
6	ISE	ISE	ISE
7	SERQ	SERQ	SERQ
8	SI	SI	SI
9	MS	MS	MS

Table 7.42: Ranking of the Sub-Factors Using Various Approaches (Research Software)

7.8 Comparison of Ranking between Medical Software and Research Software

In this thesis, two different kind of softwares were adopted to examine the applicability of the MCDA approach in assigning weights between user acceptance factors and subsequently provide a means to assign ranking of the factors. Three methods were applied including AHP, Fuzzy AHP and Fuzzy AHP $\alpha\lambda$ methods. Table 7.43 shows the comparison between the level of importance of user acceptance factors.

Rank	**Medical Software**			**Research Software**		
	AHP	FAHP-Chang	FAHP-$\alpha\lambda$	AHP	FAHP-Chang	FAHP-$\alpha\lambda$
1	IQ	IQ	IQ	PE	PE	PE
2	FC	FC	FC	IQ	IQ	IQ
3	SWQ	SWQ	SWQ	SWQ	SWQ	SWQ
4	ISE	ISE	ISE	EE	EE	EE
5	PE	PE	PE	FC	FC	FC
6	MS	EE	MS	ISE	ISE	ISE
7	SERQ	MS	SERQ	SERQ	SERQ	SERQ
8	EE	SERQ	EE	SI	SI	SI
9	SI	SI	SI	MS	MS	MS

Table 7.43: Comparison of Ranking of the Sub-Factors Between Medical Software and Research Software

The results show that different types of software display difference in how important each sub-factors is in influencing user acceptance of the software. For **medical software**, the quality of information produced by the software was the most influential factor. On the other hand, performance expectancy was shown as the most influential factor for **research related software**. Further the results shows that except for slight difference in the ranking of medical software, all these methods produces similar ranking of the sub-factors. These results provide additional support for Saaty and Tran [180] who found that AHP could provides the same ranking as any other fuzzy multi-decision analysis method. As stated by Saaty and Tran [180] *"no fuzzifying can make his/her judgments more valid in practice"*.

7.9 Applicability of MCDA in User Acceptance Studies

Evaluation of the factors that influence user acceptance of software and technology is of great importance. Undertaking evaluation studies on user acceptance of software will help to improve understanding on implementation difficulties or barriers which organizations can face. Evaluation is carried out to find the answer to five main questions which are 'why', 'what', 'who', 'when' and 'how' (described in section 2.13). This thesis examined the applicability of the multi-criteria decision analysis (MCDA) approaches to answer explicitly the question of 'which' and subsequently to answer research questions proposed in **Chapter 1**. The results obtained above showed the feasibility of adopting the MCDA method to answer the question of 'which' explicitly within evaluation studies.

The MCDA was adopted in this thesis to examine its applicability in determining the weights between decision elements which is user acceptance factors. To the best of the researcher's knowledge this method not been used to rank user acceptance factors of health-care technology or software within the health informatics area A number of studies within health-care area have adopted the AHP method but none have examined it in the context of user acceptance of the health-care technology [166, 168, 170].

This thesis examined both the classical AHP method and two variations of Fuzzy AHP method. All these methods have been shown to be applicable in providing weights between various user acceptance factor. A clearer understanding of various available methods can aid an organization to adapt those methods to better address problems involving multi-attribute decision making.

The approaches examined in this thesis are not intended to show which is the best method or technique, but rather to illustrate the various options which are available within MCDA approaches to derive weights among evaluation items and subsequently provide an answer to address the question of 'which' explicitly within evaluation research.

Various studies on user acceptance which propose models or frameworks use for example structural equation modeling (SEM) method or some other statistical methods as a means to assign weights to factors [9, 32, 33, 138]. Together with all these methods, the researcher believes that the MCDA approaches could provide further means to analyze the importance of various factors that influence user acceptance of software or technology.

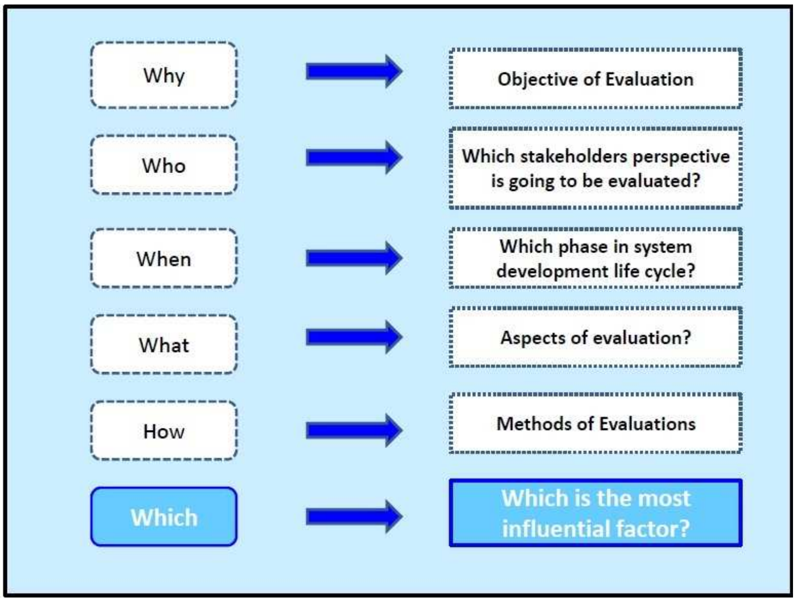


Figure 7.6: A Diagram of Proposed Novel ‘Which’ Question in Evaluation Study

7.10 Proposed Extended Dimension of User Acceptance

In this thesis, the researcher proposed the addition of another important question to user acceptance studies. This is the question of ‘which’ as shown in Figure 7.6. The dotted lines show the original questions. The solid line is the proposed novel ‘which’ question which is equally important to be addressed in almost every evaluation study.

In order to answer the last research question, 3 widely used techniques within the MCDA methodology were tested to provide the weights between decision elements. The results obtained show the applicability of the MCDA technique in answering the following research question described in **Chapter 1**:

Can the multi-criteria analysis method (MCDA) provide a means to answer the question of ‘which’ in evaluation studies?

The results obtained in this thesis support the use MCDA as a decision support tool in the health-care domain and could well applicable within education informatics. This thesis found support for the research questions that fulfill the last two objectives of this thesis as proposed in section 1.2 by providing significant evidence on the applicability of MCDA techniques to answer the research question.

7.11 Meaning of the Study

This study could contribute to user evaluation studies within health informatics area by providing addition information on evaluation by introducing the question of ‘which’. The results could as well applicable within education informatics due to the sample of respondents chosen in this study. Hopefully, the knowledge acquired in this study could also benefit many stakeholders including organizations, developers, research community and user themselves. MCDA could provides a means to assign weights to various user acceptance factors as shown in this study. Thus, reseacher believes that the results could benefit organizations who plan or implement new technology by assessing the importance of various factors that contribute towards user acceptance. The management need to know the importance of each factor that could influence acceptance. Failure to address these factors appropriately according to its level of importance could lead to failure of the system implementation.

The MCDA techniques needs to be incorporated within evaluation studies to benefit the management in particular. The more understanding management has about the level of importance of each factor, the more likely they will be able in successfully reducing the chance of failure of implementation. The management could channel their efforts to rectify problems related to acceptance by looking at the most important factor first.

From a researcher or academic perspective, the knowledge from this study emphasizes assessing ‘which’ explicitly within an user acceptance study, to assign weights between various factors. Thus, for the research community, it is important to recognize the potential use of the MCDA technique within health informatics research. Its applicability needs to be further explored as there are more techniques of MCDA than those shown in this thesis. In this thesis, only three widely known and used techniques, AHP, Fuzzy AHP Chang’s method and Fuzzy AHP α and λ method were examined and discussed. Further research could examine other MCDA approaches such as goal programming, data envelopment analysis, PROMETHEE and other methods.

Evaluation of the factors that influence user acceptance of the software technology is a crucial and important goal. Traditionally, evaluation has been carried out to find the answer to five main questions which are ‘why’, ‘what’, ‘who’, ‘when’ and ‘how’. This thesis shown that the question of ‘which’ also needs to be explicitly addressed and specifically recognised in all evaluation studies. Two distinct approaches were discussed in this thesis to determine the weighting between factors. The approaches presented in this thesis are not intended to show which is the best to be used to evaluate users' acceptance factors, but rather to illustrate some of the various options which are available to be used to derive weights among evaluation factors and, hence, to explicitly answer the question of 'which'. Future evaluation studies could explicitly incorporate the 'which' question in order to realize the maximum benefit for the various stakeholders.

7.12 Summary

This chapter discussed the second part of study in this thesis which examined three well-know methods which are Classical AHP, Fuzzy AHP Changs Method and Fuzzy AHP $\alpha\lambda$ method to assign weights between user acceptance factors. The results in this thesis shows the applicability of the MCDA approach as a decision support tool and provides a mean to answer the question of 'which' explicitly within evaluation studies particularly user acceptance studies. The fifth research question outlined in **Chapter 1** is answered and aims of this thesis are shown to be fulfilled through the results obtained in this chapter. Further, the results of the analysis provides implication for the research community focusing on user acceptance studies.

The final chapter, **Chapter 8** concludes this thesis and discusses the limitations of this thesis, the directions for future research and achieved publications derived from this work.

Chapter 8

Conclusion

Evaluation study on user acceptance is crucial for successful system implementation. Millions of dollars are being spent on the procurement of new technology for delivery of better care and services to patients and the public as a whole. The acceptance of new technology is dependent on individual users. Thus, factors that contribute towards acceptance have been widely researched and various frameworks and models have been proposed to better understand issues on user acceptance. However, these models and frameworks do not provide answers as to why the same system results in different outcomes when it is implemented in different settings. In this thesis, the importance of 'fit' is introduced to be integrated together with technology adoption models to better understand user acceptance issues. The 'fit' between user, technology and organization was proposed and empirical data was collected to validate the proposed model which introduces the perceived user-technology-organization fit as an antecedent of factors associated with user acceptance or intention to use. Further, existing evaluation studies on user acceptance do not explicitly incorporate the question of 'which'. This is addressed through the use of various methods within the Multi-criteria analysis (MCDA) approach.

In this Chapter, the contributions and conclusions of this thesis are summarised in the Section 8.1 and Section 8.2. Section 8.3 discusses the limitations of this work. Section 8.4 presents the direction of future work. Finally, the publications produced from this research are listed in Section 8.5.

8.1 Contributions

In order to reach the aim and fulfill the objectives stated in Chapter 1, this thesis has made the following contributions:

8.1.1 An Investigation of the Importance of 'Fit' in User Acceptance

The objective of this research is to illustrate the role of perceived fit between user, technology and organization as an antecedent of factors associated with user acceptance or intention to use technology. In order to achieve this objective, this thesis, first investigated existing evaluation research, particularly on user acceptance studies to identify factors associated with user acceptance. However, these factors alone could not explain low acceptance among users on successful implementations. This limitation was addressed to some extent by Ammenwerth et. al. [19] who introduced the concepts of 'fit' between task and technology. This framework emphasized that the user will perform certain task when there is 'fit' between the task they need to accomplish using the given technology. The importance of organization 'fit' was investigated and suggested in this thesis to be incorporated together with task and technology fit to address the issue surrounding technology implementation. System implementation may fail, not only if there is lack of 'fit' between user and technology, but also if there is lack of 'fit' between user and technology and with the organization itself. This was illustrated clearly during the first phase of the study where the students were generally happy with the Distiller Software but the hospital could not provide the required network speed; showing a lack of fit with the organization. Consequently, the need for organizational fit together with user and technology fit has been proposed in this thesis, in **Chapter 3**, to better understand user acceptance.

8.1.2 An Investigation of the Importance of Management Support and Information Security Expectancy

This thesis further classified identified factors as an example of good 'fit' and poor 'fit' between user and technology which was shown in **Chapter 2**. This work identified the absence of management support (MS) and information security expectancy (ISE) among various factors associated with technology acceptance. Management support is essential when new technology is introduced as shown in multiple studies [23–25]. The importance of information security is a major concern among the practitioners, when new technology is implemented. The realization on the importance of information security leads to, for example, development of security architecture [123]. Reviewing existing technology adoption models reveals the lack of support for both of these factors. Thus, this thesis proposed the inclusion of both management support and information security constructs together with factors defined by the Unified Theory of Use and Technology Acceptance (UTAUT) and the DeLone McLean IS Success Model.

8.1.3 An Extended Models of User Acceptance

This thesis further reviewed various technology adoption models and their application within the health-care domain, as discussed in **Chapter 3**. The review shows that both the UTAUT model and the IS Success Model needs further support within this domain. Although there are a number of studies employed by UTAUT and the IS Success Model, none have integrated and examined these two models as an integrated model. In this thesis, three very well known and validated models related to technology acceptance have been integrated to provide a more comprehensive model, as shown in **Chapter 3** (the UTAUT model, the IS Success Model the Task-technology Model). Integrating and extended these three models allows factors to be classified within individual, technology and organization categories. These three dimensions have been shown to be important in various literature when evaluating user acceptance factors [45, 70, 82, 83]. Thus, the factors proposed in this thesis are further classified within these three dimensions and this thesis classified all the factors defined by UTAUT and the IS Success Model together with management support and information security within these dimensions as follows:

- Individual Factors include Performance Expectancy, Effort Expectancy, Social Influence, Information Security Expectancy
- Technology Factors include Software/System Quality, Information Quality, Service Quality
- Organization Factors include Facilitating Condition, Management Support

This thesis proposed integrating and examining three models as a single and integrated model and the statistical results in **Chapter 5** show support for this integrated model. To the best of the researcher's knowledge, no study has integrated these three model and examined them as a single model before.

8.1.4 An Investigation of the Multi-Criteria Decision Analysis (MCDA) Techniques in Health Informatics

The multi-criteria decision analysis (MCDA) method has been widely used in a number of application areas, as a means to assign weights to decision elements when decision makers are faced with conflicting goals. Within the health-care sector, the use of MCDA method is quite limited especially the use of Fuzzy AHP methods. Existing evaluation studies try to find answers for the questions of who, when, why, what and how were reviewed in **Chapter 2**. However, to better manage factors associated with user acceptance, this thesis believe it is equally important to know the weights of this factors. In order to manage successful implementation, it would be helpful for the management to know the weights or level of importance of various user acceptance factors, so that the management can focus its effort accordingly. In this thesis, three methods have been applied and the results presented in **Chapter 7** shows its applicability within user acceptance research. These are Classical AHP, Fuzzy AHP Changs' Method and Fuzzy AHP α and λ method. Further, to enhance understanding of MCDA methods in assigning weights between user acceptance factors, this thesis employed two different case studies. The first case study involved assigning weights to factors associated with acceptance of medical related software. The second case study involved assigning the weights to factors associated with research related software. It was interesting to know if there was a difference between the factors influencing students acceptance of medical software and research software. This thesis further compares these factors and the results shows different types of software have different factors influencing user acceptance (in terms of level of importance).

8.1.5 An Introduction of the Question of 'Which' in User Acceptance

From investigating the applicability of multi-criteria decision analysis (MCDA) method in assigning weights to user acceptance factors, this thesis proposed the inclusion of the question of 'which' explicitly within user acceptance studies. Although the question of 'which' has been addressed implicitly in evaluation studies through various statistical methods, the use of MCDA methods as a means of answering the question of 'which', to the best of the researcher's knowledge has not been addressed in previous studies. By incorporating the MCDA method within evaluation studies shown in **Chapter 7**, this research could be enriched with the knowledge from various interdisciplinary areas.

8.2 Summary

In this thesis, the perceived user-technology-organization fit (PUTOF) is suggested as an antecedent to the factors defined by both the Unified Theory of Acceptance and Use of Technology (UTAUT) Model and the DeLone McLean IS Success Model. The importance of organization fit with technology and user should receive equivalent attention as the importance of task and technology fit. This organization fit needs to be addressed in the same detail as a task-technology fit in order to better understand user acceptance issues. The introduction of new technology is the responsibility of the organization, consequently it is important that the organization introduces the *right* technology to achieve its intended objectives. The technology needs to 'fit' the users skills, requirements and knowledge. The facility provided by the organization needs to 'fit' the requirement of the technology being introduced. The organization needs to support the use of technology by providing a good working environment as well as allowing a reasonable transition time from previous working practice to new working practice. All these have been shown to be important in this study. Thus, organization 'fit' together with user and technology 'fit' are substantial in understanding those factors that influence user acceptance.

This study integrated three well-known models of technology acceptance and examined them as a single model. The integrated model could explain more factors than a stand-alone model. Moreover, to the best of the researcher's knowledge, no study has previously integrated these three models as a single model with an emphasize on perceived user-technology-organization fit (PUTOF) as an antecedent of the left-hand side constructs defined by both UTAUT and the IS Success Model factors. This thesis, further, introduced two new factors which are integrated within the proposed model, to contribute towards better understanding of user acceptance of technology. The proposed model could be tested further in various contexts and settings depending on the objectives of the study. Why implementation of technology succeeds or fails, this thesis believes, it can be explained from examining the existence of 'fit' between user, technology and organization. The greater the fit between these three elements, the greater will be the influence of 'fit' on factors associated with user acceptance or intention to use technology.

In this thesis, the researcher does not explicitly aim to introduce another new model or framework of user acceptance rather to emphasize the importance of 'fit' and that the inclusion of 'fit' factors within existing evaluation frameworks could better explain user intention to adopt and use technology. With almost all hypotheses significantly supported by the statistical results, it is reasonable to accept the proposed integrated and extended model of UTAUT and the IS Success Model which suggests perceived user-technology-organization fit (PUTOF) as an antecedent factor. Although the UTAUT model specifies the influence of moderating factors such as age, gender, experiences and voluntary nature of use in determining user acceptance and use of technology, this thesis did not analyze the influence of moderating factors as it is beyond the scope of this thesis. However, some questions on moderating factors were included in the research questionnaire whereby the respondent was questioned on the influence of age, gender and experience on their intention to use medically related software. The data were analyzed to provide supportive evidence to previous studies which looked at the effect of moderating factors [52]. Moderating factors may or may not have a direct effect on intention to use and is very much dependent on the user, the setting and the environment in which the technology is used [44].

This thesis applied partial least squares (PLS) path modeling which is widely used in information system areas [2]. Furthermore, this technique can deal with complex models, and permits small sample sizes as well as violations of the normal distribution assumption. Information system practitioners should not only focus on well-defined constructs such as performance expectancy (PE), effort expectancy (EE), social influence (SI), software quality (SWQ), service quality (SERQ), information quality (IQ) etc to study influencing factors but also take into consideration the existence of fit between user-technology-organization which could equally help in explaining intention toward adoption and use of technology. 11 hypotheses were defined and WarpPLS 3.0 was used to test the model. Both measurement model and structural model fitted well to the data which were within acceptable limits. In addition, convergent and discriminant validities of the measurement model were also verified. The empirical results in this thesis suggest that perceived user-technology-organization fit can influence users' perception on effort, performance, information security, software quality, information quality, service quality, facilitating condition and management support directly, which has been overlooked in past literatures. Although fit between task and technology has been addressed in number of publications, the importance of organization fit within user fit and technology fit has not received great attention. The results discussed in **Chapter 6** showed perceived user-technology-organization fit to be a core determinant of performance expectancy (PE), effort expectancy (EE), software quality (SWQ), information quality (IQ), service quality (SERQ), management support (MS), facilitating condition (FC), and information security expectancy (ISE). The results also demonstrated that intention to use medically related software could be explained by the management support (MS) and information security expectancy (ISE) factors.

As there are many factors that could affect technology acceptance apart from the 9 constructs introduced in the proposed model, the variance explained by the model, R^2=0.11 (PE), R^2=0.16 (EE), R^2=0.13 (SI), R^2=0.17 (FC), R^2=0.27 (SWQ), R^2=0.10 (IQ), R^2=0.22 (SERQ), R^2=0.20 (MS), R^2=0.23 (ISE), R^2=0.33 (ITU) are considered reasonable . The more a user believe in the existence of fit between them, the technology and the organization, the higher will be the influence of these factors on intention to use technology. The importance of organization fit with technology and user should receive the same attention as the task and technology fit, to better understand user acceptance issues. The proposed model should be seen as complementary to the existing models suggested in the literature. Both UTAUT and the IS Success Model have also been shown to be applicable in the healthcare context and should receive equivalent attention when considering issues related to user acceptance of health care technology. Further, both ISE and MS could have an influence on user intention to use the software or technology and these factors should be incorporated within technology adoption models.

Development of new technology or software depends on the sector it is meant to support and each sector may have different factors that contribute towards technology adoption. Consequently numerous evaluation frameworks are present within evaluation studies and each framework works well within their individual context. Within the health care industry, the importance of information security should not be ignored and needs to be evaluated. The results in this thesis provide evidence of the importance of fit between user, technology and organization as a direct determinant of various factors that influence intention to use. Any factors that contribute towards successful adoption dependent on the existence of fit between user-technology and organization. These factors may vary but perceived fit between user-technology-organization (PUTOF) will largely determine these factors. This study has implications to the organization, the software developer and to the research community in evaluation studies within health informatics research.

This thesis emphasized the role of 'fit' between user, technology and organization as an antecedent of factors influencing user acceptance. Further, it introduced two new constructs which are management support and information security expectancy. This model was empirically examined within the health-care domain. The 'generic' features of the model, i.e the defined constructs, should allow the model to be further examined in other domains.

Further, this thesis investigates the applicability of multi-criteria decision analysis (MCDA) methods to assign weights to user acceptance's factors. Three widely used methods, classical AHP, Fuzzy AHP Chang's method and Fuzzy AHP α and λ method were applied to provide weights between decision elements and the results shows that all these methods produced similar ranking of the factors. The applicability of MCDA is shown in this thesis, thus MCDA could provides a means of answering the question of 'which' explicitly in user acceptance studies.

8.3 Thesis Limitation

Although this thesis makes a contribution to the body of evaluation research particularly user acceptance studies in health informatics, it has several limitations that need to be identified as discussed below.

i One of the important limitations of this thesis is related to the choice of population sample to test the proposed theoretical model and sample size. As described in the section 4.3.1, the initial population sample was shifted from real practitioners of medical software to medical students' intention to use the medical software. Due to time limitation, only students were used to empirically test the proposed theoretical model. Further, the sample size is small compared to previous studies on technology acceptance for example work by Kijsanayotin *et. al* [70] who examined a sample of 1607 community health centres users to determine factors influence user adoption of health information technology. Although, it is important to focus on real users of the medical software and to have satisfactory sample sizes to produce reliable results and draw appropriate conclusion, this thesis, through using PLS techniques, produced statistically significant and satisfactory results to guide future studies. Nevertheless, caution when generalizing the results of this thesis should be taken, as they reflect students' perspectives in the context of medically related software and not actual users of medical software.

ii Another potential limitation is related to the measurement items for perceived user-technology-organization fit (PUTOF) used in this thesis. The measurement items may not fully capture the constructs due to limited literature on the items measuring this construct. That is, the items measuring PUTOF which are adopted from a number of studies including [96, 221, 227] may be seen as 'overlapping' with the measurement items of the UTAUT and IS Success Model construct itself. Nevertheless, careful consideration was given to develop the measurement items for each of the LVs to ensure minimal redundancy. Although there are various studies discussing the task-technology fit with its measurement items, to measure the organization fit together with user and technology is a challenge and limited literature was available to adopt in this thesis.

iii This thesis does not hypothesize any direct relationship between constructs defined by both UTAUT and the IS Success Model with Intention to Use except for information security expectancy (ISE) and Management Support (MS). As stated in **Chapter 1**, the objective of this thesis is to hypothesize relationships which have not been tested in previous studies. Furthermore, due to time limitation and the objectives of this thesis, this relationship was not tested.

iv This thesis does not incorporate actual usage behaviour due to using a sample of medical students and not real users of the medical software. The sample of this study has been shifted from real users of the actual medical software to *potential* users, who are medical students. Further, instead of measuring actual usage of the medical software, this thesis measures intention to use. Nevertheless, substantial empirical support exists on the causal link between intention to use technology and actual usage behaviour [70, 79, 229, 272] which means that users who believe or have an intention to use technology are likely to actually use the technology in future.

v This study demonstrated how the empirical data fits with the proposed theoretical model through statistical analysis. The statistical analysis shows the reliability and validity of the constructs as well as the proposed relationships in this thesis. These empirical data might work with other models related to technology acceptance such as the Technology Acceptance Model (TAM) [12], the Theory of Reasoned Action (TRA) [72] and the Theory of Planned Behavior (TPB) [73] but is not tested in this study.

vi This thesis employed several multi-criteria decision analysis (MCDA) methods to enhance evaluation studies on user acceptance by explicitly including the question of ‘which’. There are various other methods of MCDA as mentioned in **Chapter 2** which are yet to be tested.

vii Finally, this study only examined the direct relationships between defined constructs in the model and does not consider the inter-relationships between the constructs as well as the effect of moderating factors.

8.4 Future Work

Future work should address the limitation of this study described above as follows:

i Validate the proposed model among actual users and measure actual usage behavior instead of user intention.

ii Testing the direct relationships between constructs defined by UTAUT and IS Success Model with Intention to Use. By testing these relationships the results hopefully could provide better prediction to the proposed model.

iii Test the empirical data with other models related to technology acceptance such as Technology Acceptance Model (TAM), the Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB) and compared the results obtained with the proposed model in this thesis.

iv Explore the inter-relationship effects between various variables defined in the proposed model towards user intention to use technology. Also to investigate the effect of moderating factors such as age, gender, experience on user acceptance.

v As for second part of research in this thesis, future researchers could look into other MCDA techniques such as Fuzzy Cognitive Methods, Goal Programming, Data Envelopment Analysis etc. Hopefully analyzing these other methods could provide additional support for the MCDA methods to be included in the medical informatics research area.

In summary, future study should consider the inclusion of real users, investigating the acceptance of specific medical software, measuring the actual usage behaviour as well as measuring the inter-relationship among constructs in order to manipulate and strengthen the applicability of the proposed theoretical model suggested in this thesis.

8.5 Dissemination

The research work reported in this thesis has been used in conference papers as well as internal and international talks. This section lists the publications and presentations derived from this work together with a references to the chapter in which the topic is covered.

8.5.1 Conference Publications

1. K.S-Mohamadali, N.A, Garibaldi, J.M., Understanding and Addressing the 'Fit' Between User, Technology and Organization in Evaluating User Acceptance of Healthcare Technology, in Proceedings of International Conference on Health Informatics (HEALTHINF2012), pg 119-124, Vilamoura, Algarve, Portugal, February 1-4, 2012. -(**Chapter 2 and Chapter 3**).

2. K.S-Mohamadali, N.A, Garibaldi, J.M., Including Explicitly the Question of 'Which' in Evaluation Study, in Proceedings of International Conference on Health Informatics (HEALTHINF2012), pg. 341-344, Vilamoura, Algarve, Portugal, February 1-4, 2012. -(**Chapter 7**).

3. K.S-Mohamadali, N.A, Garibaldi, J.M., A Novel Evaluation Model of User Acceptance of Software Technology in Health-Care Sector, in Proceedings of International Conference on Health Informatics (HEALTHINF2010), pg. 392-397, Valencia,Spain, January 20-23, 2010 -(**Chapter 3**).

4. K.S-Mohamadali, N.A, Garibaldi, J.M., Towards the Development of Novel Evaluation Framework for Information Systems in Health-Care Sector, in Proceedings of International Conference on Health Informatics (HEALTHINF 2009), pg. 17-24, Porto, Portugal, January 14-17, 2009. -(**Chapter 2**).

8.5.2 Presentations

- Understanding and Addressing the 'Fit' Between User, Technology and Organization in Evaluating User Acceptance of Healthcare Technology (oral presentation) at the International Conference on Health Informatics (HEALTHINF 2012), Vilamoura, Algarve, Portugal, 3rd February 2012.

- Including Explicitly the Question of ‘Which’ in Evaluation Study (poster presentation) at the International Conference on Health Informatics (HEALTHINF 2012), Vilamoura, Algarve, Portugal, 2nd February 2012.
- Modelling Students’ Perception on Factor Influence Acceptance of Research Related Software Using Multi-Criteria Decision Analysis (MCDA) Methods at the 11th Annual Workshop on Computational Intelligence (UKCI 2011), Manchester, 9th September 2011.
- Comparing User Acceptance Factors Between Research Software and Medical Software Using AHP and Fuzzy AHP at the 11th Annual Workshop on Computational Intelligence (UKCI 2011), Manchester, 9th September 2011.
- Modelling Students Perception on Factors Influence Acceptance of Research Related Software using Multi-criteria Decision Analysis Techniques (MCDA). A case study(oral presentation) at Intelligent Modelling and Analysis Research Group seminar, School of Computer Science, University of Nottingham, Nottingham, UK, 10th June 2011.
- Modeling User Acceptance of Software Technology using AHP and Fuzzy AHP (oral presentation) at Intelligent Modelling and Analysis Research Group seminar, School of Computer Science, University of Nottingham, Nottingham, UK, 11th May 2010.
- Towards the Development of Novel Evaluation Framework for Information Systems in Health-Care Sector (oral presentation) at the International Conference on Health Informatics (HEALTHINF2009), Porto, Portugal, 16th January 2009.
- Evaluation Studies in Health Informatics and a Proposed Integrated Model of Technology Acceptance for Health Information Systems (oral presentation) at Intelligent Modelling and Analysis Research Group seminar, School of Computer Science, University of Nottingham, Nottingham, UK, 28th April 2009.

Bibliography

[1] Friedman C. P. and Wyatt J. C. *Evaluation Methods in Medical Informatics*. Springer-Verlag, New York, 1997.

[2] Urbach N. and Ahlemann F. Structural Equation Modeling in Information Systems Research Using Partial Least Squares. *Journal of Information Technology Theory and Application (JITTA)*, 11:5–40, 2010.

[3] Saaty T. L. How to make a decision: The Analytic Hierarchy Process. *European Journal of Operational Research*, 48:9–26, 1990.

[4] Wu H. Y., Tzeng G. H., and Chen Y. H. A fuzzy MCDM approach for evaluating banking perfromance based on Balance Scorecard. *Expert Systems with Applications*, 36:10135–10147, 2009.

[5] Wyatt J. C. and Liu J. L. Y. Basic concepts on medical informatics. *Journal of Epidemiology and Community Health*, 56:808–812, 2002.

[6] Blois M. S. What Is Medical Informatics? *The Western Journal of Medicine*, 145:776–777, 1986.

[7] Goodman C. S. and Ahn R. Methodological approaches of health technology assessment. *International Journal of Medical Informatics*, 56:97–105, 1999.

[8] Chambers M., Connor S. L., McGarvey H., and Diver M. User acceptance of a multi-media software application to increase preparedness for caring problems. *Health Informatics Journal*, 7:152–157, 2001.

[9] Wu J. H., Wang S. C., and Lin L. M. Mobile computing acceptance factors in the healthcare industry: A structural equation model. *International Journal of Medical Informatics*, 76:66–77, 2007.

[10] Yi M. Y., Jackson J. D., Park J. S., and Probst J. C. Understanding information technology acceptance by individual professionals: Towards an integrative view. *Information and Management*, 43:350–363, 2006.

[11] Martens J. D., Weijden T. V. D., Winkes R. A. G., Kester A. D. M., Geerts P. J. H., Evers S. M. A. A., and Severens J. L. Feasibility and acceptability of a computerised system with automated reminders for prescribing behaviour in primary care. *International Journal of Medical Informatics*, 77:199–207, 2008.

[12] Davis F. D. Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information Technology. *MIS Quarterly*, 13:319–339, 1989.

[13] DeLone W. H. and McLean E. R. The DeLone and McLean Model of Information Systems Success: A Ten Year Update. *Management Information Systems*, 19(4):9–30, 2003.

[14] Goodhue D. L. and Thompson R. L. Task-technology fit and individual performance. *MIS Quarterly*, 19:213–236, 1995.

[15] Schaper L. K. and Pervan G. P. Ict and OTs: A model of information and communication technology acceptance and utilisation by occupational therapists. *International Journal of Medical Informatics*, 76s:S212–S221, 2007.

[16] Yusof M. M., Kuljis J., Papzafeiropoulou A., and Stergioulas L. K. An evaluation framework for Health Information Systems: human, organization and technology-fit factors (HOT-fit). *International Journal of Medical Informatics*, 77:386–398, 2008.

[17] Hu P. J., Chau P. Y. K., Sheng O. R. L., and Tam K. Y. Examining the Technology Acceptance Model Using Physician Acceptance of Telemedicine Technology. *Journal of Management Information Systems*, 16:91–112, 1999.

[18] Tsiknakis M. and Kouroubali A. Organizational factors affecting successful adoption of innovative ehelath services: A case study employing the FITT framework. *International Journal of Medical Informatics*, 78:39–52, 2009.

[19] Ammenwerth E., Iller C., and Mahler C. It-adoption and the interaction of task, technology and individuals: a fit framework and a case study. *BMC Medical Informatics and Decision Making*, 6:1–13, 2006.

[20] Bretz R. D. and Judge T. A. Person-Organization Fit and the Theory of Work Adjustment: Implication for Satisfaction, Tenure, and Career Success. *Journal of Vocational Behavior*, 44:32–54, 1994.

[21] Chatman J. A. Improving Interactional Organizational Research: A Model of Person-Organization Fit. *Academy of Management Review*, 14:333–349, 1989.

[22] Kaplan B. and Shaw N. Future Directions in Evaluation Research: People, Organizational, and Social Issues. *Methods of Information in Medicine*, 43:215–231, 2004.

[23] Randell R. and Dowding D. Organisational influences on nurses' use of clinical decision support system. *International Journal of Medical Informatics*, 79:412–421, 2010.

[24] Ragu-Nathan B. S., Apigian C. H., T.S. Ragu-Nathan T. S., and Tu Q. A path analytic study of the effect of top management support for information system performance. *Omega*, 32:459–471, 2004.

[25] Igbaria M., Guimaraes T., and Davis G. B. Testing the Determinants of Microcomputer Usage via Structural Equation Model. *Journal of Management Information Systems*, 11(4):87–114, 1995.

[26] Blobel B. Authorisation and access control for electronic health record system. *International Journal of Medical Informatics*, 73:251–257, 2004.

[27] Haas S., Wohlgemuth S., Echizen I., Sonehara N., and Muller G. Aspects of privacy for electronic health records. *International Journal of Medical Informatics*, 80:e26–e31, 2011.

[28] Wyatt J. C. and Wyatt S. M. When and how to evaluate information systems? *International Journal of Medical Informatics*, 69:251–259, 2003.

[29] Jen W. Y. and Chao C. C. Measuring mobile patient safety information system success: An empirical study. *International Journal of Medical Informatics*, 77:689–697, 2008.

[30] Goodhue D. L. Understanding User Evaluation of information systems. *Management Science*, 41:1827–1844, 1995.

[31] Kristof A.L. Person-Organization Fit: An Integrative Review of Its Conceptualzations, Measurement and Implications. *Personnel Psychology*, 49:1–49, 1996.

[32] Steele R., Lo A., Secombe C., and Wong Y. K. Elderly persons' perception and acceptance of nursing wireless sensor networks to assist healthcare. *International Journal of Medical Informatics*, 78:788–801, 2009.

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

[34] Venkatesh V., Morris M. G., Davis G. B., and Davis F. D. User Acceptance of information technology: toward a unified views. *MIS Quarterly*, 27:425–478, 2003.

[35] Delone W. H. and McLean E. R. Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research*, 3:60–95, 1992.

[36] Cooper D. R. and Schindler P. S., editors. *Business Research Methods*. McGraw-Hill, 2008.

[37] Anderson J. C. and Gerbing D. W. Structural Equation Modeling in Practice: A Review and Recommended Two-Step Approach. *Psychological Bulletin*, 103:411–423, 1988.

[38] Collen M. F. Origins of Medical informatics. *The Western Journal of Medicine*, 145:778–785, 1986.

[39] Abdul-Kareem S., Baba S., and Wahid M.I.A. Research in medical informatics. *Health Informatics Journal*, 6:110–115, 2000.

[40] Carnevale R. J and Aronsky D. The life and death of URLs in five biomedical informatics journals. *International Journal of Medical Informatics*, 76:269–273, 2007.

[41] Bath P. A. Health informatics: current issues and challenges. *Health Informatics Journal*, 34:501–518, 2008.

[42] Haux R. Aims and tasks of medical informatics. *International Journal of Medical Informatics*, 44:9–20, 1997.

[43] Chiasson M., Reddy M., Kaplan B., and Davidson E. Expanding multi-disciplinary approaches to healthcare information technologies: What does information systems offer medical informatics? *International Journal of Medical Informatics*, 76s:S89–S97, 2007.

[44] Laerum H., Ellingsen G., and Faxvaag A. Doctors' use of electronic medical records systems in hospitals: cross sectional survey. *BMJ*, 323:1344–1348, 2001.

[45] Lorenzi N. M. Imia Working Group 13: organizational impact of medical informatics. *International Journal of Medical Informatics*, 56:5–8, 1999.

[46] Bickford C. J., Smith K, Ball M. J., Frantz G., Panniers T. L., Newbold S. K., Knecht K. L., Farish-Hunt H., and Cortes-Comerer N. Evaluation of a nursing informatics training program shows significant changes in nurses' perception of their knowledge of information technology. *Health Informatics Journal*, 11:225–235, 2005.

[47] Urquhart C. and Currell R. Reviewing the evidence on nursing record systems. *Health Informatics Journal*, 11:33–44, 2005.

[48] Anderson N. R., Ash J. S., and Tarczy-Hornoch P. A qualitative study of the implementation of a bioinformatics tool in a biological research laboratory. *International Journal of Medical Informatics*, 76:821–828, 2007.

[49] Talmon J. L. and Hasman A. Medical informatics as a Discipline at the Begining of the 21st Century. *Methods Inf Med*, 41:4–7, 2002.

[50] Heathfield H., Pitty . D, and Hanka R. Evaluating information technology in health care:barriers and challenges. *BMJ*, 316:1959–1961, 1998.

[51] Ammenwerth E. and Keizer N. An inventory of evaluation studies of information technology in health care: Trends in evaluation research 1982-2002. *MedInfo*, page 1289, 2004.

[52] Ayatollahi H., Bath P. A., and Goodacre S. Factors influencing the use of IT in the emergency department: A qualitative study. *Health Informatics Journal*, 16:189–200, 2010.

[53] Bleich H. L. and Slack W. V. Reflections on electronic medical records: When doctors will use them and when they will not. *International Journal of Medical Informatics*, 79:1–4, 2010.

[54] Chang I. C., Hwang H. G., Hung W. F., and Li Y. C. Physicians' acceptance of pharmacokinetics-based clinical decision support systems. *Expert Systems with Applications*, 33(2):296–303, 2007.

[55] Chaudhry B., Wang J., Wu S., Maglione M., Mojica W., Roth E., Morton S. C., and Shekelle P. G. Systematic Review: Impact of Health Information Technology on Quality, Efficiency, and Costs of Medical Care. *Annals of Internal Medicine*, 144:1–30, 2006.

[56] Kushniruk A. W. and Patel V. L. Cognitive and usability engineering methods for the evaluation of clinical information systems. *Journal of Biomedical Informatics*, 37:56–76, 2004.

[57] Brender J. Methodology for constructive assessment of IT-based systems in an organisational context. *International Journal of Medical Informatics*, 56:67–86, 1999.

[58] Despont-Gros C., Mueller H., and Lovis C. Evaluating user interactions with clinical information systems: A model based on human-computer interaction models. *Journal of Biomedical Informatics*, 38:244–255, 2005.

[59] Meijden M. J. V., Tange H. J., Troost, and Hasman A. Determinants of Success of Inpatient Clinical Information Systems: A Literature Review. *Journal of the American Medical Association*, 10:235–243, 2003.

[60] Handy J., Whiddett R., and Hunter I. A Technology Acceptance Model for Inter-Organisational Electronic Medical Record Systems. *Australasian Journal of Information Systems*, 9 (1):39–49, 2001.

[61] May C., Mort M., Mair F., Ellis N. T., and Gask L. Evaluation of new technologies in health-care systems:what's the context? *Health Informatics Journal*, 6:67–70, 2000.

[62] Bossen C. Evaluation of a computerized problem-oriented medical record in a hospital department:Does it support daily clinical practice? *International Journal of Medical Informatics*, 76:592–600, 2007.

[63] Lemire M., Pare G., Sicotte C., and Harvey C. Determinants of Internet use as a preferred source of information on personal health. *International Journal of Medical Informatics*, 77:723–734, 2008.

[64] Olola C. H. O., Narus S., Nebeker J., Poynton M., Hales J., Rowan B., LeSieur H., Zumbrennen C., Edwards A. A., Crawford R., Amundsen S., Kabir Y., Atkin J., Newberry C., Young J., Hanifi T., Risenmay B., Sorensen T., and Evans R. S. The perception of medical professionals and medical students on the usefulness of an emergency medical card and a continuity of care report in enhancing continuity of care. *International Journal of Medical Informatics*, 80:412–420, 2011.

[65] Royle J. A., Blythe J., DiCenso A., Boblin-Cummings S., Deber R., and Hayward R. Evaluation of a system for providing information resources to nurses. *Health Informatics Journal*, 6:100–109, 2000.

[66] Vest J. R. More than just a question of technology: Factors related to hospitals' adoption and implementation of health information exchange. *International Journal of Medical Informatics*, 79:797–806, 2010.

[67] Bansler J. P. and Havn E. Pilot implementation of health information systems: Issues and challenges. *International Journal of Medical Informatics*, 79:637–648, 2010.

[68] Petter S. and Fruhling A. Evaluating the success of an emergency response medical information system. *International Journal of Medical Informatics*, 2011.

[69] Wakefield D. S., Mehr D., Keplinger L., Canfield S., Gopidi R., Wakefield B. J., Koopman R. J., Belden J. L., Kruse R., and Kochendorfer K. M. Issues and questions to consider in implementing secure electronic patient-provider web portal communication systems. *International Journal of Medical Informatics*, 79:469–477, 2010.

[70] Kijsanayotin B., Pannarunothai S., and Speedie S. M. Factors influencing health information technology adoption in Thailand's community health centers: Applying the UTAUT model. *International Journal of Medical Informatics*, 78:404–416, 2009.

[71] Aggelidis V. P. and Chatzoglou P. D. Using a modified technology acceptance model in hospitals. *International Journal of Medical Informatics*, 78:115–126, 2009.

[72] Fishbein M. and Ajzen I., editors. *Belief, attitude, intention and behavior: An introduction to theory and research*. Addison-Wesley, 1975.

[73] Ajzen I., editor. *From intentions to actions: a theory of planned behaviour*. Springer-Verlag, 1985.

[74] Ajzen I. The Theory of Planned Behavior. *Organizational Behavior and Human Decision Process*, 50:179–211, 1991.

[75] O'Boyle C. A., Henly S. J., and Larson E. Understanding adherence to hand hygiene recommendations: The theory of planned behavior. *Americal Journal of Infection Control*, 29:352–360, 2001.

[76] Millstein S. G. Utility of the theories of reasoned action and planned behavior for predicting physician behavior: A prospective analysis. *Health Psychology*, 15:398–402, 1996.

[77] Venkatesh V. and Davis F. D. A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science*, 46(2):186, 2000.

[78] Holden R. J. and Karsh B. T. The Technology Acceptance Model: Its past and its future in health care. *Journal of Biomdecial Informatics*, 43:159–172, 2010.

[79] Chau P. Y. K. and Hu P. J. Investigating healthcare professionals' decisions to accept telemedicine technology: an empirical test of competing theories. *Information and Management*, 39:297–311, 2002.

[80] Venkatesh V. Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information Systems Research*, 11:342–365, 2000.

[81] Petter S. and McLean E. R. A meta-analytic assessment of the Delone and McLean IS success model: An examination of IS success at the individual level. *Information and Management*, 46:159–166, 2009.

[82] Bharati P. and Chaudhury A. An empirical investigation of decision-making satisfaction in web-based decision support systems. *Decision Support Systems*, 37:187–197, 2004.

[83] Yusof M. M. and Papazafeiropoulou A. Investigating evaluation frameworks for health information systems. *International Journal of Medical Informatics*, 77:377–385, 2008.

[84] Goodhue D. L., Klein B. D., and March S. T. User Evaluation of IS as surrogates for objective performance. *Information and Management*, 38:87–101, 2000.

[85] Lauver K. J. and Kristof-Brown A. Distinguishing between Employees' Perceptions of Person-Job and Person-Organization Fit. *Journal of Vocational Behaviour*, 59:454–470, 2001.

[86] Heeks R. Health information systems: Failure, success and improvisation. *International Journal of Medical Informatics*, 75:125–137, 2006.

[87] Southon G., Sauer C., and Dampney K. Lessons from a failed information systems initiative: issues for complex organisations. *International Journal of Medical Informatics*, 55:33–46, 1999.

[88] Lorenzi N. M. and Riley R. T. Organizational issues = change. *International Journal of Medical Informatics*, 69:197–203, 2003.

[89] Winter A. F., Ammenwerth E., Bott O. J., Brigl B., Buchauer A., Graber S., Grant A., Haber A., Hasselbring W., Haux R., Heinrich A., Janssen H., Kock I., Penger O. S., Prokosch H. U., Terstappen A., and Winter A. Startegic information management plans: the basis for systematic information management is hospitals. *International Journal of Medical Informatics*, 64:99–109, 2001.

[90] Bush M., Lederer A. L., Li X., Palmisano J., and Rao S. The alignment of information systems with organizational objectives and strategies in health care. *International Journal of Medical Informatics*, 78:446–456, 2009.

[91] Verquer M. L., Beehr T. A., and Wagner S. H. A meta-analysis of relations between person-organization fit and work attitudes. *Journal of Vocational Behavior*, 63:473–489, 2003.

[92] Hong K. K. and Kim Y. G. The critical success factors for ERP implementation: An organizational fit perspective. *Information & Management*, 40(1):25–40, 2002.

[93] Yen D. C., Wu C. S., Cheng F. F., and Huang Y. W. Determinants of user's intention to adopt wireless technology: An empirical study by integrating TTF and TAM. *Computer in Human Behavior*, 26(5):906–915, 2010.

[94] Chang H. H. Task-technology fit and user acceptance of online auction. *International Journal of Human-Computer Studies*, 68:69–89, 2010.

[95] Dishaw M. T. and Strong D. M. Extending the technology acceptance model with task-technology fit constructs. *Information and Management*, 36:9–21, 1999.

[96] Zhou T., Lu Y., and Wang B. Integrating TTF and UTAUT to explain mobile banking user adoption. *Computers in Human Behavior*, 26:760–767, 2010.

[97] Thompson R. L., Higgins C. A., and Howell J. M. Personal Computing: Toward a Conceptual Model Utilization. *MIS Quarterly*, 15:125–143, 1991.

[98] Goodhue D. L. I/s Attitudes: Toward Theoretical and Definitional Clarity. *Database*, 19:6–15, 1988.

[99] Meade B., Buckley D., and Boland M. What factors affect the use of electronic patient records by Irish GPs? *International Journal of Medical Informatics*, 78:551–558, 2009.

[100] Larsen T. J., Sorebo A. M., and Sorebo O. The role of task-technology fit as user's motivation to continue information system use. *Computers in Human Behavior*, 25:778–784, 2009.

[101] Travers D. A. and Downs S. M. Comparing User Acceptance of a Computer Systemin Two Pediatric Offices: A Qualitative Study. *American Medical Informatics Association*, pages 853–857, 2000.

[102] Lee T. T., Mills M. E., Bausell B., and Lu M. H. Two-stage evaluation of the impact of a nursing information system in Taiwan. *International Journal of Medical Informatics*, 77:698–707, 2008.

[103] Folz-Murphy N., Partin M., Williams L., Harris C. M., and Lauer M. S. Physician Use of an Ambulatory Medical Record System: Matching Form and Function. *American Medical Informatics Association*, pages 260–264, 1998.

[104] Bowns I. R., Rotherham G., and Paisley S. Factors associated with success in the implementation of information management and technology in the NHS. *Health Informatics Journal*, 5:136–145, 1999.

[105] Carayon P., Hundt A. S., and Wetterneck T. B. Nurses' acceptance of Smart IV Pump technology. *International Journal of Medical Informatics*, 79:401–411, 2010.

[106] Harper G. R. and Utley D. R. Organizational Culture and Successful Information Technology in Implementation. *Engineering Management Journal*, 13:11–15, 2001.

[107] Lammintakanen J., Saranto K., and Kivinen T. Use of electronic information systems in nursing management. *International Journal of Medical Informatics*, 79:324–331, 2010.

[108] Ellis N.T. and May C.R. Computers and the general practice consultation. *Health Informatics Journal*, 5:124–127, 1999.

[109] Short D., Frischer M., and Bashford J. Barriers to the adoption of computerized decision support systems in general practice consultations: a qualitative study of GPs' perspectives. *International Journal of Medical Informatics*, 73:357–362, 2004.

[110] Arun Vishwanath A. and Scamurra S. D. Barriers to the adoption of electronic health records: using concept mapping to develop a comprehensive empirical model. *Health Informatics Journal*, 13:119–134, 2007.

[111] Campion T. R., Waitman L. R., May A K., Ozdas A., Lorenzi N. M., and Gadd C. S. Social, organizational and contextual characteristics of clinical decision support systems for intensive insulin therapy: A literature review and case study. *International Journal of Medical Informatics*, 79:31–43, 2010.

[112] Teo T. S. H. and Ang J. S. K. An examination of major IS planning. *International Journal of Information Managament*, 21:457–470, 2001.

[113] Igbaria M., Zinatelli N., Cragg P., and Cavaye A. L. M. Personal Computing Acceptance Factors in Small Firms: A Structural Equation Model. *Management Information System Quarterly*, 21(3):279–302, 1997.

[114] Igbaria M. End-User Computing Effectiveness. *International Journal of Management Science*, 18:637–652, 1990.

[115] Lu Y. C., Xiao Y., Sears A., and Jacko J. A. A review and a framework of handheld computer adoption in healthcare. *International Journal of Medical Informatics*, 74:409–422, 2005.

[116] Davis F. D. User Acceptance of information technology: system characteristics, user perceptions and behavioural impacts. *International Journal of Man-Machine Studies*, 38:475–487, 1993.

[117] Samy G. N., Ahmad R., and Ismail Z. Security threats categories in healthcare information systems. *Health Informatics Journal*, 16:201–209, 2010.

[118] Ivanov V. I., Yu P. L., and Baras J. S. Securing the communication of medical information using local biometric authentication and commercial wireless links. *Health Informatics Journal*, 16:211–223, 2010.

[119] Ayatollahi H., Bath P. A., and Goodacre S. Accessibility versus confidentiality of informations in the emergency department. *Emergency Medical Journal*, 26:857–860, 2009.

[120] Ferreira A., Antunes L., Chadwick D., and Corrie R. Grounding information security in healthcare. *International Journal of Medical Informatics*, 79:268–283, 2010.

[121] Choe J. and Yoo S. K. Web-based secure access from multiple patient repositories. *International Journal of Medical Informatics*, 77:242–248, 2008.

[122] Cavalli E., Mattasoglio A., Pinciroli F., and Spaggiari P. Information security concepts and practices: the case of a provincial multi-specialty hospital. *International Journal of Medical Informatics*, 73:297–303, 2004.

[123] Gritzalis D. and Lambrinoudakis C. A security architecture for interconnecting health information systems. *International Journal of Medical Informatics*, 73:305–309, 2004.

[124] Goodhue D. L. and Straub D. W. Security concerns of system users: A study of perceptions of the adequacy of security. *Information and Management*, 20:13–27, 1991.

[125] Heathfield H. A., Peel V., Hudson P., Kay S., and Mackay L. Evaluating Large Scale Health Information System: From Practice Towards Theory. In *Proc AMIA Annual Fall Symp*, 1997.

[126] Sittig D. F., Ash J. S., and Guappone K. P. Accessing the anticipated consequences of Computer based Provider Order Entry at three community hospitals using an open-ended, semi-structured survey instruments. *International Journal of Medical Informatics*, 77:440–447, 2008.

[127] Palm J. M., Colombet I., and Sicotte C. Determinants of User Satisfaction with a Clinical Information System. In *AMIA 2006 Symposium Proceeding*, 2006.

[128] Shaw N. T. Cheats: a generic information communication technology (ICT) evaluation framework. *Computers in Biology and Medicine*, 32:209–220, 2002.

[129] Grant A., Plante I., and Leblanc F. The TEAM methodology for the evaluation of information systems in biomedicine. *Computers in Biology and Medicine*, 32:195–207, 2002.

[130] Kazanjian A. and Green C. J. Beyond effectiveness: the evaluation of information systems using a comprehensive health technology assessment framework. *Computers in Biology and Medicine*, 32:165–177, 2002.

[131] Sicotte C., Pare G., Pierre M., and Paccioni A. A Risk Assessment of Two Inter organizational Clinical Information Systems. *Journal of the American Medical Informatics Association*, 13:557–566, 2006.

[132] Kaplan B. Evaluating informatics applications clinical decision support systems literature review. *International Journal of Medical Informatics*, 64:15–37, 2001.

[133] Seddon P. and Kiew M. Y. A Partial Test and Development of Delone and Mclean's Model of IS Success. *Australasian Journal of Information Systems*, 4:90–109, 1996.

[134] Nahm E. S., Vaydia V., Ho D., Scharf B., and Seagull J. Outcome assessment of clinical information system implementation: A practical guide. *Nursing Outlook*, 55:282–288, 2007.

[135] Yusof M. M., Kuljis J., Papazafeiropoulou A., and Stergioulas L. K. An evaluation framework for Health Information Systems: human, organization and technology-fit factors (HOT-fit). *International Journal of Medical Informatics*, 77:386–398, 2008.

[136] Ash J. and Berg M. Report of conference Track 4: socio-technical issues of HIS. *International Journal of Medical Informatics*, 69:305–306, 2003.

[137] Gremy F., Fessler J. M., and Bonnin M. Information systems evaluation and subjectivity. *International Journal of Medical Informatics*, 56:13–23, 1999.

[138] Schectman J. M., Schorling J. B., Nadkarni M. M., and Voss J. D. Determinants of physician use of an ambulatory presciption expert system. *International Journal of Medical Informatics*, 74:711–717, 2005.

[139] Otieno G. O., Hinako T., Motohiro A., Daisuke K., and Keiko N. Measuring effectiveness of electronic medical records systems: Towards building a composite index for benchmarking hospitals. *International Journal of Medical Informatics*, 77:657–669, 2008.

[140] Dolan J. G. Shared decision-making - transferring research into practice: The Analytic Hierarchy Process (AHP). *Patient Education and Counseling*, 73:418–425, 2008.

[141] Saaty T. L. An exposition of the AHP in reply to the paper ”remarks on the analytic hierarchy process”. *Management Science*, 36:259–268, 1990.

[142] Salmeron J. L. and Herrero I. A ahp-based methodology to rank critical success factors of executive information systems. *Computer Standards and Interfaces*, 28:1–12, 2005.

[143] Chin K. S., Pun K. F., Xu Y., and Chan J.S.F. An AHP based study of critical factors for TQM implementation in Shanghai manufacturing industries. *Technovation*, 22:707–715, 2002.

[144] Bodin L. and Gass S. L. On teaching the analytic hierarchy process. *Computer and Operations Research*, 30:1487–1497, 2003.

[145] Vaidya O. S. and Kumar S. Analytic hierarchy process: An overview of applications. *European Journal of Operational Research*, 169:1–29, 2006.

[146] Liberatore M. J. and Nydick R. L. The analytic hierarchy process in medical and health care decison making: A literature review. *European Journal of Operational Research*, 189:194–207, 2008.

[147] Fu H. P., Ho Y. C., Chen R. C. Y., Chang T. H., and Chein P. H. Factors affecting the adoption of electronic marketplaces. *International Journal of Operation and Production Management*, 26:1301–1324, 2006.

[148] Badri M. A. A combined AHP-GP model for quality control systems. *International Journal of Production Economics*, 72:27–40, 2001.

[149] Lee C. W. and Kwak N. K. Information resource planning for a health-care system using an AHP-based goal programming method. *Journal of the Operational Research*, 50:1191–1198, 1999.

[150] Kwong C. K. and Bai H. A fuzzy AHP approach to the determination of importance weights of customer requirements in quality function deployment. *Journal of Intelligent Manufacturing*, 13:367–377, 2002.

[151] Saaty T. L. *The Analytic Hierarchy Process*. RWS, Pittsburgh, 1994.

[152] Zadeh L. A. Fuzzy sets. *Information and Control*, 8:338–353, 1965.

[153] Buyukozkan G., Kahraman C., and Ruan D. A fuzzy multi-criteria decision approach for software development strategy selection. *International Journal of General Systems*, 33:259–280, 2004.

[154] Van-Laarhoven P. J. M. and Pedrycz W. A Fuzzy Extension of Saaty's Priority Theory. *Fuzzy Sets and Systems 11*, 11:229–241, 1983.

[155] Buckley J. J. Fuzzy hierarchical analysis. *Fuzzy Sets and Systems*, 17:233–247, 1985.

[156] Boender C.G.E., de Graan J.G., and Loostma F.A. Multi-criteria decision analysis with fuzzy pairwise comparisons. *Fuzzy Sets and Systems*, 29:133–143, 1989.

[157] Chang D. Y. Applications of the extent analysis method on fuzzy AHP. *European Journal of Operational Research*, 95:649–655, 1996.

[158] Cheng C. H. Evaluating naval tactical missile systems by fuzzy AHP based on the grade value of membership function. *European Journal of Operational Research*, 96:343–350, 1996.

[159] Leung L. C. and Cao D. On consistency and ranking of alternatives in fuzzy AHP. *European Journal of Operational Research*, 124:102–113, 2000.

[160] Chang C. W, Wu C. R., and Lin H. L. Applying fuzzy hierarchy multiple attributes to construct an expert decision making process. *Expert Systems with Applications*, 36:7363–7368, 2009.

[161] Bozbura F. T., Beskese A., and Kahraman C. Prioritization of human capital measurement indicators using fuzzy AHP. *Expert Systems with Applications*, 32:1100–1112, 2007.

[162] Lin C. T., Lee C., and Chen W. Y. Using fuzzy analytic process to evaluate service performance of a travel intermediary. *The Service Industries Journal*, 29:281–296, 2009.

[163] Csutora R. and Buckley J. J. Fuzzy hierarchical analysis: the Lambda-Max method. *Fuzzy Sets and Systems*, 120:181–195, 2001.

[164] Macharis C., Springael J., Brucker K. D., and Verbeke A. Promethee and AHP: The design of operational synergies in multicriteria analysis. Strengthening PROMETHEE with ideas of AHP. *European Journal of Operational Research*, 153:307–317, 2004.

[165] Kok K. The potential of Fuzzy Cognitive Maps for semi-quantitative scenario development, with an example from Brazil. *Global Environment Change*, 19:122–133, 2009.

[166] Rossetti M. D. and Selandari F. Multi-objective analysis of hospital delivery systems. *Computer and Industrial Engineering*, 41:309–333, 2001.

[167] Singpurwalla N., Forman E., and Zalkind D. Promoting shared health care decision making using the analytic hierarchy process. *Socio-Economic Planning Sciences*, 33:277–299, 1999.

[168] Topacan U., Basoglu A. N., and Daim T. U. Ahp Application on Evaluation of Health Information Service Attributes. In *PICMET 2009 Proceedings*, 2009.

[169] Sloane E. B., Liberatore M. J., Nydick R. L., Luo W., and Chung Q. B. Using the analytic hierarchy process as a clinical engineering tool to facilitate an iterative, multidisciplinary, microeconomic health technology assessment. *Computers and Operations Research*, 30:1447–1465, 2003.

[170] Hariharan S., Dey P. K., and Chen D. R. Application of analytic hierarchy process for measuring and comparing the global performance of intensive care units. *Journal of Critical Care*, 20:117–125, 2005.

[171] Ho W. Integrated analytic hierarchy process and its applications - A literature review. *European Journal of Operational Research*, 186:211–228, 2008.

[172] Muralidhar K. and Santhanam R. Using the Analytic Hierarchy Process for Information System Project Selection. *Information & Management*, 18:87–95, 1990.

[173] Tiummala V. M. R., Chin K. S., and Ho S. H. Assessing success factors for implementing CE: A Case study in Hong Kong electronics industry by AHP. *International Journal of Production Economics*, 49:265–283, 1997.

[174] Liu Z. and Inooka H. Application of Extended AHP to the Analysis of User's Acceptance of Environment-friendly Car. *Interdisciplinary Information Sciences*, 4:29–38, 1998.

[175] Ahsan M. K. and Bartlema J. Monitoring healthcare performance by analytic hierarchy process: a developing-country perspective. *International Transactions in Operational Research*, 11:465–478, 2004.

[176] Rodriguez-Repiso L., Setchi R., and Salmeron J. L. Modelling IT projects success with Fuzzy Cognitive Maps. *Expert Systems with Applications*, 32:543–559, 2007.

[177] Chen M. K. and Shih-Ching Wang. The critical factors of success for information service industry in developing international market: Using analytic hierarchy process (AHP) approach. *Expert Systems with Applications*, 37:694–704, 2010.

[178] Hariharan H., Dey P. K., Moseley H. S. L., Kumar A. Y., and Gora J. A new tool for measurement of process-based performance of multispeciality tertiary care hospitals. *International Journal of Health Care Quality Assurance*, 17:302–312, 2004.

[179] Agrawal R. K. Modelling technology acceptance: a methodology for assimilating users' perception. *International Journal of Technology Intelligence and Planning*, 5:1–21, 2009.

[180] Saaty T. L. and Tran L. T. On the invalidity of fuzzifying numerical judgments in the Analytic Hierarchy Process. *Mathematical and Computer Modelling*, 46:962–975, 2007.

[181] SlidePath. Distiller. Available from http://www.slidepath.com, 2008.

[182] Sapsford R. and Jupp V., editors. *Data Collection and Analysis*. Sage Publisations Ltd, 2006.

[183] Yin R. K., editor. *Case Study Research: Design and Methods*. Sage Publisations Ltd, 2009.

[184] Burton-Jones A. and Hubona G. S. The mediation of external variables in the technology acceptance model. *Information and Management*, 43:706–717, 2006.

[185] Venkatesh V. and Davis F. D. A Model of the Antecedents of Perceived Ease of Use: Development and Test. *Decision Sciences*, 27:451–481, 1996.

[186] Huh H. J., Kim T., and Law R. A comparison of competing theoretical models for understanding acceptance behaviour of information systems in upscale hotels. *International Journal of Hospitality Management*, 28:121–134, 2009.

[187] Palvia P. C. and Palvia S. C. The examination of the IT Satisfaction of small-business users'. *Information and Management*, 35:127–137, 1999.

[188] Alter S. Are the fundamental concepts of information systems mostly about work systems? *Communication of the Association for Information Systems*, 6:1–69, 2001.

[189] Ahmed F., Capretz L. F., and Sheik S. A. Institutionalization of software product line: An empirical investigation of key organizational factors. *The Journal of Systems and Software*, 80:836–849, 2007.

[190] Drazin R. and Van de Ven A. H. Alternative Forms of Fit in Contingency Theory. *Administrative Science Quarterly*, 30:514–539, 1985.

[191] Donaldson L., editor. *The Contigency Theory of Organizations*. Sage Publisations Series, 2001.

[192] Clegg S. R., Hardy C., and Nord W. R., editors. *Handbook of Organization Studies*. Sage Publisations Ltd, 2003.

[193] Chin W. W. and Todd P. A. On the Use, Usefulness and Ease of Use of Structural Equation Modeling in MIS Research : A Note of Caution. *MIS Quarterly*, 19(2):185–211, 1995.

[194] Chau P. Y. K. and Hu P. J. Information Technology Acceptance by Individual Professionals: A Model Comparison Approach. *Decision Sciences*, 32(4):699–719, 2001.

[195] Short D., Frischer M., and Bashford J. Barriers to the adoption of computerised decision support systems in general practice consultations: a qualitative study of GPs perspectives. *International Journal of Medical Informatics*, 73(4):357–362, 2004.

[196] Karahanna E., Straub D. W., and Chervany N. L. Information Technology Adoption Across Time: A Cross-Sectional Comparison of Pre-Adoption and Post-Adoption Beliefs. *MIS Quarterly*, 23(2):183–213, 1999.

[197] Palvia P. C. A model and instrument for measuring small business user satisfaction with information technology. *Information and Management*, 31:151–163, 1996.

[198] Rai A., Lang S. S., and Welker R. B. Assessing the Validity of IS Success Models: An Empirical Test and Theoretical Analysis. *Information Systems Research*, 13(1):50–69, 2002.

[199] Luo X., Gurung A., and Shim J. P. Understanding the Determinants of User Acceptance of Enterprise Instant Messaging: An Empirical Study. *Journal of Organizational Computing and Electronic Commerce*, 20:155–181, 2010.

[200] Gaunt N. Installing an appropriate information security policy. *International Journal of Medical Informatics*, 49:131–134, 1998.

[201] Neame R. and Olson M. J. Security issues arising in establishing a regional health information infrastructure. *International Journal of Medical Informatics*, 73:285–290, 2004.

[202] Katsikas S. K. Health care management and information systems security: awareness, training or education? *International Journal of Medical Informatics*, 60:129–135, 2000.

[203] der Haak M. V., Wolff A. C., Brander R., Drings P., Wannenmacher M., and Wetter T. Data security and protection in cross-institutional electronic patient records. *International Journal of Medical Informatics*, 70:117–130, 2003.

[204] der Linden H. V., Kalra D., Hasman A., and Talmon J. Inter-organizational future proof EHR systems: A review of the security and privacy related issues. *International Journal of Medical Informatics*, 78:141–160, 2009.

[205] Sucurovic S. Implementing security in a distributed web-based EHCR. *International Journal of Medical Informatics*, 76:491–496, 2007.

[206] Adeogun O., Tiwari A., and Alcock J.R. Models of information exchange for UK telehealth systems. *International Journal of Medical Informatics*, 80:359–370, 2011.

[207] Smith E. and Eloff J.H.P. Security in health-care information systems-current trends. *International Journal of Medical Informatics*, 54:39–54, 1999.

[208] Lafky D. B. and Horan T. A. Personal health records: Consumer attitudes toward privacy and security of their personal health information. *Health Informatics Journal*, 17:63–71, 2011.

[209] Guimaraes T., Igbaria M., and Lu M. T. The determiants of DSS Success: An Integrated Modelling. *Decision Sciences*, 23:409–430, 1992.

[210] Lawrence M. and Low G. Exploring Individual User Satisfaction Within User-Led Development. *MIS Quarterly*, 17:195–208, 1993.

[211] Mahmood M. A., Burn J. M., Gemoets L. A., and Jacquez C. Variables affecting information technology end-user satisfaction: a meta-analysis of the empirical literature. *International Journal of Human Computer Studies*, 52:751–771, 2000.

[212] Satzinger J. W. and Olfman L. Computer Support for Group Work: Perception of the Usefulness of Support Scenarios and End-User Tools. *Journal of Management Information Systems*, 11:115–148, 1995.

[213] Kaplan B. and Duchon D. Combining Qualitative and Quantitative Methods in Information Systems Research: A Case Study. *Management Information System Quarterly*, 12:571–586, 1988.

[214] Ammenwerth E., Graber S., Herrmann G., Burkle T., and Konig J. Evaluation of health information systems-problems and challenges. *International Journal of Medical Informatics*, 71:125–135, 2003.

[215] Fricker R. D. and Schonlau M. Advantages and Disadvantages of Internet Research Surveys: Evidence from the Literature. *Field Methods*, 14:347–367, 2002.

[216] Pfleeger S. L. and Kitchenham B. A. Principles of Survey Research Part 1: Turning Lemon into Lemonade. *Software Engineering Notes*, 26:16–18, 2001.

[217] Hair J. F., Money A. H., Samouel P., and Page M., editors. *Research methods for business*. John Wiley & Sons, 2003.

[218] Wilkinson D. and Birmingham P., editors. *Using Research Instruments : A Guide for Researchers*. RoutledgeFalmer, 2003.

[219] Hair J. F., Black W. C., Babin B. J., and Anderson R. E. *Multivariate Data Analysis*. Pearson, 2010.

[220] Chuchill G. A. A paradigm for Developing Better Meaures of Marketing Constructs. *Journal of Marketing Research*, 16:64–73, 1979.

[221] Schierz P. G., Schilke O., and Wirtz B. W. Understanding consumer acceptance of mobile payment services: An empirical analysis. *Electronic Commerce Research and Applications*, 9:209–216, 2010.

[222] Gallego M. D., Luna P., and Bueno S. User acceptance model of open source software. *Computers in Human Behavior*, 24:2199–2216, 2008.

[223] Teo T. Modelling technology acceptance in education: A study of pre-service techers. *Computers & Education*, 52:302–312, 2009.

[224] Aibinu A. A. and Al-Lawati A. M. Using PLS-SEM technique to model construction organizations' willingness to participate in e-bidding. *Automation in Construction*, 19:714–724, 2010.

[225] Chellappa R. K. and Pavlou P. A. Perceived information security, financial liability and consumer trust in electronic transactions. *Journal of Enterprise Information Management*, 15, 2002.

[226] Chow T. and Cao D. B. A survey study of critical success factors in agile software projects. *The Journal of Systems and Software*, 81:961–971, 2008.

[227] Lin T. C. and Huang C. C. Understanding knowledge management system usage antecedents: An integration of social cognitive theory and task technology fit. *Information and Management*, 45:410–417, 2008.

[228] Dawes J. Do data characteristics change according to the number of scale points used? : An experiment using 5-point, 7-point and 10-point scales. *International Journal of Market Research*, 50:61–77, 2008.

[229] Kim C., Mirusmonov M., and Lee I. An empirical examination of factors influencing the intention to use mobile payment. *Computers in Human Behaviour*, 26:310–322, 2010.

[230] Kitchenham B. A. and Pfleeger S. L. Principles of Survey Research Part 3: Constructing a Survey Instrument. *Software Engineering Notes*, 27:20–24, 2002.

[231] Podsakoff P. M., Mackenzie S. B., and Lee J. Y. Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies. *Journal of Applied Psychology*, 88:879–903, 2003.

[232] Kitchenham B. and Pfleeger S. L. Principles of Survey Research Part 4: Questionnaire Evaluation. *Software Engineering Notes*, 27:20–24, 2002.

[233] Bailey J. E. and Pearson S. W. Development of a tool for measuring and analyzing computer user satisfaction. *Management Science*, 29:530–545, 1983.

[234] Gefen D., Straub D., and Boudreau M. C. Structural Equation Modeling and Regression: Guideline for Research Practice. *Communications of the Association for Information Systems*, 4:1–70, 2000.

[235] Haenlein M. and Kaplan A. M. A Beginner's Guide to Partial Least Squares Analysis. *Understanding Statistics*, 3:283–297, 2004.

[236] Chin W. W. *Handbook of Partial Least Squares*, chapter 28, pages 655–690. Springer-Verlag, 2010.

[237] Fornell C. and Bookstein F. L. Two Structural Equation Models: LISREL and PLS Applied to Consumer Exit-Voice Theory. *Journal of Marketing Research*, 19:440–452, 1982.

[238] Vinzi V. E., Chin W.W., Henseler J., and Wang H., editors. *Handbook of Partial Least Squares: concepts, methods and applications*. Springer-Verlag, 2010.

[239] Chin W. W. Partial Least Square is to LISREL as principal components analysis is to common factor analysis. *Technology Studies*, 2:315–319, 1995.

[240] Chin W. W., Marcolin B. L., and Newsted P. R. A partial least squares latent variable modeling approach for measuring interaction effects: Results from a monte carlo simulation study and voice mail emotion/adoption study. *Information Systems Research*, 14:189–217, 2003.

[241] Wetzels M., Odekerken-Schroder G., and Oppen C. V. Using PLS Path Modeling for Assessing Hierarchical Construct Models: Guidelines and Empirical Illustration. *MIS Quarterly*, 33:177–195, 2009.

[242] Hair J. F., Ringle C. M., and Sarstedt M. Pls-sem: Indeed a Silver Bullet. *The Journal of Marketing Theory and Practice*, 19:139–152, 2011.

[243] *WarpPLS 2.0 User Manual*.

[244] Kock N. Using WrapPLS in e-collaboration studies: An Overview of main analysis steps. *International Journal of e-collaboration*, 6:1–13, 2010.

[245] Kock N. Using WarpPLS in e-Collaboration Studies: Descriptive Statistics, Settings, and Key Analysis Results. *International Journal of e-Collaboration*, 7(2):1–18, 2011.

[246] Montazemi A. R. Factors Affecting Information Satisfaction in the Context of the Small Business Environment. *MIS Quarterly*, 12:239–256, 1988.

[247] Hulland J. Use of partial least squares (PLS) in strategic management research: a review of four recent studies. *Strategic Management Journal*, 20:195–204, 1999.

[248] Straub D., Boudreau M. C., and Gefen D. Validation Guidelines for IS Positivist Research. *Communication of AIS*, 13:380–427, 2004.

[249] Fornell C. and Larcker D. F. Evaluating Structural Equation Models with Unobservable Variables and Measurement error. *Journal of Marketing Research*, 18:39–50, 1981.

[250] Nunnally J. C. *Psychometric theory*. McGraw-Hill:New York, 1994.

[251] Barclay D., Higgings C., and Thompson R. The partial least squares (PLS) approach to casual modeling: Personal computer adoption and use as an illustration. *Technology Studies*, 2:285–309, 1995.

[252] Henseler J., Ringle C. M., and Sinkovics R. R. The use of partial least squares path modeling in international marketing. *New ChallengestoInternationalMarketing Advances inInternationalMarketing EmeraldGroupPublishingLimited*, pages 277–319, 2009.

[253] Diamantopoulos A. and Siguaw J. A. Formative Versus Reflective Indicators in Organizational Measure Development: A Comparison and Empirical Illustration. *British Journal of Management*, 17:263–282, 2006.

[254] Byrne B. M. *Structural Equation Modeling with LISREL, PRELIS and SIMPLIS: Basic concepts, applicatons and programming*. Lawremce Erlbaum Associates, 1998.

[255] Breiman L. and Friedman J. H. Estimating Optimal Transformations for Multiple Regression and Correlation. *Journal of the American Statistical Association*, 80:580–598, 1985.

[256] Chin W. W. *The partial least squares approach to structural equation modeling*, chapter Ten, page 295. Lawremce Erlbaum Associates, 1998.

[257] Geisser S. The Predictive Sample Reuse Method with Applications. *Journal of the American Statistical Association*, 70:320–328, 1975.

[258] Stone M. Cross-Validatory Choice and Assessment of Statistical Predictions. *Journal of the Royal Statistical Society*, 36:111–147, 1974.

[259] Cohen J. A Power Prime. *Psychological Bulletin*, 112:155–159, 1992.

[260] Chin W. W. Issues and opinion on structural equation modeling. *MIS Quarterly*, 22:vii–xvi, 1998.

[261] Williams L. J. and Brown B. K. Method Variance in Organizational Behavior and Human Resources Research: Effects on Correlations, Path Coefficients, and

Hypothesis Testing. *Organizational Behavior and Human Decision Processes*, 57:185–209, 1994.

[262] Chang S. J., Witteloostuijn A. V., and Eden L. From the Editors: Common method variance in international business research. *Journal of International Business Studies*, 41:178–184, 2010.

[263] Kline R. B. *Principles and practice of structural equation modeling*. Guilford Press, 2005.

[264] Gumussoy C. A. and Calisir F. Understanding factors affecting e-reverse auction use: An integrative approach. *Computers in Human Behavior*, 25:975–988, 2009.

[265] Shegog R., Bartholomew L. K., Sockrider M. M., Czyzewski D. I., and Pilney S. Computer-based decision support for pediatric asthma management: description and feasibility of the Stop Asthma Clinical System. *Health Informatics Journal*, 12(4):259–273, 2006.

[266] Jiang J. J., Klein G., Roan J., and Lin J. T. M. Is service performance:self-perception and user perceptions. *Information & Management*, pages 499–506, 2001.

[267] Procaccino J. D., Verner J. M., Shelfer K. M., and Gefen D. What do software practitioners really think about project success: an exploratory study. *The Journal of Systems and Software*, 78:194–203, 2005.

[268] Jiang J. J., Klein G., and Discenza R. Perception differences of software success:provider and user views of system metrics. *The Journal of Systems and Software*, 63:17–27, 2002.

[269] Zahedi F. The analytic hierarchy process: A Survey of the Method and its Applications. *Interfaces*, 16:96–108, 1986.

[270] Celik M., Deha Er I., and Ozok A. F. Application of fuzzy extended AHP methodology on shipping registry selection: The case of Turkish maritime industry. *Ex*, 36:190–198, 2009.

[271] Wu C. R., Lin C. T., and Chen H. C. Integrated environmental assessment of the location selection with fuzzy analytical network process. *Quality and Quantity*, 43:351–380, 2009.

[272] Hamner M. and Qazi R. Expanding the Technology Acceptance Model to examine Personal Computing Technology utilization in government agencies in developing countries. *Government Information Quarterly*, 26:128–136, 2009.

Appendix A

Output from Pilot Study

Phase 1: Interview with Students who use Distiller Software
Objective: To identify factor Influence Students' Acceptance of the Software
Period of Study: November 2009
Number of Participants : 4

Date :
Venue/Location:
Start Time
End Time:
Questions:

1. How long have you been using this software in your work?
2. What are the purposes of the software?
3. Have you heard about the software prior to using it?
4. Do you have any experiences using similar software?
5. Do you think experience important in influencing your use of the software?
6. Do you it is easy to use the software?
7. Do you think software is user-friendly?
8. Do you think the software save your time?
9. What is your opinion with the data produced by the software?
10. Do you think the interaction with the software is clear and understandable?
11. Do you think or believe using the software has improved your job performance?
12. Do you think your use of the software influences by other colleagues using the same software?
13. Do you have necessary facility to use the software?
14. Other than receiving helpdesk support, do you get support from your department/school itself?
15. How about the support from your supervisor, who introduce you with the software?
16. Does the software installed in your computer?
17. Have you experienced any network problem while using the software?
18. Have you experienced any data crashed or lost issues?
19. Do you think it is important to attend training before start using the software?
20. What do you think about the speed of the system or software?
21. How about the functionality provided by the software?
22. What is your opinion on the quality of the software you are using?
23. Can you get up-to-date data?
24. What is your opinion on the security of the information provided by the software?
25. What is your opinion on the helpdesk support provided by the vendor? Do you think it is helpful?
26. Will you continue to use the software in future?
27. In general, what are the important factors that have influence your use / acceptance of the software?

Participant_1

Date: 4th November 2009
Venue: MOL Seminar Room 3
Start Time: 13:45 pm
End Time: 14:15

1. Almost a year
2. To analyze and perform scoring
3. No
4. I use software but not to analyze cell, it is to analyze DNA.
5. Yes
6. Yes
7. Yes
8. Yes
9. I'm happy with it.
10. Yes
11. Yes
12. Yes
13. Yes, I have high resolution screen computer
14. I get support from my supervisor. If I have problem, I contact him.
15. Yes
16. Yes
17. Twice
18. No..no..I am very careful with that
19. Not necessary. My suporvisor explain to me how to use the software.
20. Sometime slow
21. In the begining I found it too many option. Then when I become use to it, it is useful.
22. It is a very good software. However it terms of zooming, it is not enough. So i have to use microscope.
23. yes
24. I need to have more authority to access the system.
25. No
26. yes
27. Easy to use / support from supervisor

Participant_2

Date: 2nd November 2009
Venue: Molecular Medical Science Teaching Facility, QMC
Start Time :11:15
End Time : 11:55

1. May be 1 year ago
2. Scoring, marker and downloading data for analyzing my data
3. Yes by Andy.
4. First time
5. It may save time but experience not necessary.
6. It has too many functions
7. Yes
8. Yes
9. Its fine and can't understand.
10. Its fine
11. Yes i think it improve
12. No
13. Yes, Andy gave me high resolution computer
14. And and IT people but mainly Andy
15. Very supportive
16. Its web-based. Can access from any computer
17. Server was slow but now it is ok
18. Never. It is reliable
19. No. Only seminar on how to use the software by Andy.
20. Slow. I use huge amount of data and it is slow in the process of downloading.
21. It is fine. I don't find anything is over of missing
22. We use machine called nano zommer in the department and the image is high resolution. It is fine.
23. yes
24. Yes. I can choose what I want and I can download and it has right level of information security.
25. no
26. Yes. If I need any data, I will use it
27. Save time / Quick / Access in terms of level of authorization / Very important is the support from Andy

Participant_3

Date: 11th November 2009
Venue: City Hospital
Start Time : 12:15:00
End Time : 12:45:00

1. 1 year
2. Scoring purpose
3. No
4. No
5. No, basically it is not difficult to us it. It is quite straightforward.
6. Yes
7. Yes
8. No. Uploading images are bit long and downloading was slow.
9. Output is fine
10. Yes
11. It didn't
12. No
13. Not really. I have to go to QMC to use high resolution screen computer
14. No
15. Yes
16.
17. I have my own computer however the internet connection in this hospital is not the best.
18. Yes. Two or three times even
19. Yes. Briefed by Andy and detail induction by software IT assistant.
20. Quite Slow
21. Fine
22. I am not confident with the scanned image provided by the system.
23. No
24. It is fine as I have been right authorization to access the software
25. It was alright however at certain point they couldn't do it more.
26. No
27. Induction course / Very organized customer service like helpdesk support / good infrastructure.

Participant_4

Date: 11th November 2009
Venue: Centre of Bimolecular Sciences Room C50
Start Time : 09:30
End Time : 10:05

1. a year and half
2. Scoring
3. No
4. it was my first time
5. Yes
6. Yes it is pretty easy
7. Yes
8. Yes
9. Very good and easy to understand.
10. It was fine
11. yes in good way
12. No. I just finish my work faster
13. Yes
14. IT people (Jagdish) and Andy. I usually call And first if I have problem.
15. Yes
16.
17. Yes sometime but the problem usually from the distiller itself.
18. Yes
19. No. Andy gave the seminar and it did not take long time because the software is simple.
20. Speed
21. Enough and they should increase the option accoring to the needs of the users.
22. Yes it is good.
23. Yes
24. Not really.
25. No
26. Yes
27. Who introduce the software should provide the support needed.

Appendix B

Questionnaire 1

QUESTIONNAIRE_1

Understanding and Identifying Factor Influence User Acceptance of Medical Related Software

Dear Participant,
My name is Noor Azizah KS Mohamadali, a postgraduate student at the School of Computer Science, University of Nottingham, United Kingdom. I am currently conducting a study on user acceptance of medical software which my dissertation will be about.

The purpose of this study is to examine factors influence user acceptance of medical software.

The eligibility requirement of the study is that you have used some software in your clinical work (or throughout/during your course of study, during placement, during medical practice etc) at some point in the last two years (it does not matter which software, or for how long you have used it). Or if you are at early stage of you study and believe at some point in future you will learn or use any medically related software, you are also eligible to participate in this study.

Please note that factors such as user's experience with the software, age and gender are measured as moderating factors in our study rather than as direct factors. These moderating factors, depending on the environment, may or may not have a direct effect on user acceptance of software technology, but the study will allow for this.

Based on your opinion, please **CHOOSE** appropriate answer(s). Your participation in this study is greatly appreciated. All the participants and answers will remain anonymous. Data collected from this study will be available solely for research purpose. Since NO personal information, such as your name or any other defining characteristics, are collected, this will NOT be included in ANY report, under ANY circumstances.

I will appreciate it if you could answer the questions as completely as possible. The questionnaire should take NO longer than 10 minutes of your time. Thanks in advance for your participation.

Regards,
Noor Azizah KS MOHAMADALI,
Phd candidate,
School of Computer Science,
University of Nottingham
mnk@cs.nott.ac.uk
Phone No: 0115 95 14229

Assoc. Prof. Jonathan M. Garibaldi
Supervisor,
School of Computer Science
University of Nottingham
jmg@cs.nott.ac.uk
PhoneNo: +44 (0) 115 95 14216

SECTION A: BACKGROUND INFORMATION

1. Gender: ❑ Male ❑ Female

2. Age Range: ❑ < 20 years ❑ 20 – 29 years ❑ 30 – 39 years ❑ 40 – 49 years ❑ 50 years+

3. Year of Study: ❑ First Year ❑ Second Year ❑ Third Year ❑ Fourth Year ❑ Fifth Year ❑ Other: ___________________________

4. University/ Centre: ____

5 School/Faculty/Division: ____.

6. Country: ____

7. Do you currently learn/use any medically related software? ❑ Yes ❑ No

   If yes, what is the name of the software: ____

8. Do you think in future you will be using any medically related software in your workplace?

   ❑ Yes ❑ No

9. Do you think having **previous experience** of using different software for the same purpose(s) is important in influencing acceptance of the software**?**

   ❑ Yes ❑ No

10. Do you think **age** will have some degree of influence in the use/acceptance of the software?

    ❑ Yes ❑ No

11. Do you think **gender** will have some degree of influence in the use of the software?

    ❑ Yes ❑ No

SECTION B: USER ACCEPTANCE FACTOR

Please read this instruction carefully:

Assuming you are currently using **(or in FUTURE WILL USE)** any medically related software (for example patient management software), please indicate the extent to which you *agree or disagree* ***(level of agreement)*** with the following statements. (Check ✓ your answer.)

Level of Agreement	Strongly Disagree 1	Disagree 2	Uncertain 3	Agree 4	Strongly Agree 5
Given an opportunity, I will use the software in my healthcare practice.	○	○	○	○	○
I intend to use medically related software in my practice as frequent as possible.	○	○	○	○	○
It is important that organization provides training and documentation which is specific to the job role of the user.	○	○	○	○	○
I believe data confidentiality, data integrity and data availability are important features of any clinical related software.	○	○	○	○	○
I believe it is important that internal technical assistances are available to solve problems related to the software.	○	○	○	○	○
It is important that outputs produced by medically related software are clear, precise, readable and consistent.	○	○	○	○	○
I believe medically related software would provide all the necessary functions to perform my intended tasks related to healthcare practise (functionality).	○	○	○	○	○
It is important the software provides features that prevent unauthorized or disclosure of Information to protect data confidentiality or privacy issues.	○	○	○	○	○

Level of Agreement	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
	1	2	3	4	5
I use the software because departmental co-workers also use it	○	○	○	○	○
I believe that outputs provided by medically related software would be sufficient to enable me to do required tasks.	○	○	○	○	○
I believe by using medically related software it would improve my effectiveness in the healthcare practice	○	○	○	○	○
By using medically related software, I believe related tasks would be done more quickly.	○	○	○	○	○
It is important that the software provides features which prevent or reduce users' error, e.g. preventing medication error.	○	○	○	○	○
I believe it is important that management provides a supportive working environment such as pleasant work place, sufficient work space, sufficient numbers of computers etc.	○	○	○	○	○
I believe medically related software providers' supports are important to be available at all the time to solve problems related to software malfunction (empathy).	○	○	○	○	○
It is important that management allows a reasonable transition period from previous medically related software to current software	○	○	○	○	○
I believe if medically related software is user-friendly, I would easy for me to use it.	○	○	○	○	○
I believe it would be relatively easy to retrieve records using medically related software.	○	○	○	○	○

Level of Agreement	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
	1	2	3	4	5
I believe that medically related software's provider need to have knowledge to do their job well (assurance).	○	○	○	○	○
I believe medically related software would be easy to use and be helpful to the doctors, nurses and other clinicians in providing care to the patients.	○	○	○	○	○
When there is a problem with medically related software, I believe it is important that service provider solves the problem at reasonable time period (reliability).	○	○	○	○	○
It is important that necessary resources are provided by the management to able the user to use the medical software.	○	○	○	○	○
Using medically related software would improve my job performance in the healthcare practice	○	○	○	○	○
People who influence my behavior think I should use the software.	○	○	○	○	○
It is important that medically related software provides output in understandable format	○	○	○	○	○
I believe it is important that management provides necessary support such as training, encouragement etc, which could influence me to use the medically related software.	○	○	○	○	○
It is important that the software provides features which prevent unauthorized modification of information to protect data integrity.	○	○	○	○	○
I believe using medically related software would improve my healthcare practice.	○	○	○	○	○
It is important that introduction of new medically related software is communicated to the user of the software.	○	○	○	○	○

Level of Agreement	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
	1	**2**	**3**	**4**	**5**
I believe medically related software would be easy to use, flexible and provides benefits to my healthcare practice.	○	○	○	○	○
I estimate it would be easy for me to become skilful at using medically related software in my healthcare practice.	○	○	○	○	○
I estimate there would be high chance of me using medically related software in my healthcare practice.	○	○	○	○	○
People who are important to me think I should use the software.	○	○	○	○	○
I believe it is important that management provides encouragement to innovate and improve working practice through the use of medically related software.	○	○	○	○	○
It is important that medically related software's response time or speed meets the requirement of the healthcare practice.	○	○	○	○	○
I believe by using medically related software it would enhance my productivity towards providing quality services to the public.	○	○	○	○	○
I believe it is important that management provides technical assistance when I having trouble finding or using data.	○	○	○	○	○
Medically related software provider need to be willing to help and give prompt services to user (responsiveness).	○	○	○	○	○
It is important that medically related software provides up-to-date information which is available 24/7 or whenever service is needed.	○	○	○	○	○

Level of Agreement	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
	1	2	3	4	5
I believe it is important that the skills and knowledge I have fit with the medically related software introduced by the organization	○	○	○	○	○
I believe it is important that management provides medically related software that fit the way I work which allow for convenient and easy access to the data.	○	○	○	○	○
It is important that management ensures that medically related software is fit or compatible with existing setting or architectures of the current software in the organization.	○	○	○	○	○
I believe it is important that management provides medically related software which fit my expectation on software features such as secure, fast and reliable information and services at all time.	○	○	○	○	○

SECTION C: Perceived FIT between INDIVIDUAL, TECHNOLOGY AND ORGANIZATION

The example of **fit between individual, technology and organization** are given below. Please refer to this example to answer the questions below.

Fit	Example
Fit between Individual and Technology	An individual needs to have the right skills and knowledge to be able to use the software effectively.
Fit between Individual and Organization	An organization needs to provide necessary training to enable user to use the software effectively. An organization needs to provide the right facilities and support to the user to enable the user to use the software effectively.
Fit between Technology and Organization	An organization needs to provide the right software which will help to accomplish the intended jobs/tasks or organization objectives. Software needs to be compatible with existing settings or architecture of the current systems in the organization and if not the organization needs to take an appropriate action before the introduction of new software.

With respect to any medically related software, please indicate the extent to which you agree or disagree with given statement.

Level of Agreement	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
	1	2	3	4	5
Fit between Individual and Technology	○	○	○	○	○
Fit between Individual and Organization	○	○	○	○	○
Fit between Technology and Organization	○	○	○	○	○

12. If the use of software is optional, I will use it in future ○ Yes ○ No

13. In your opinion, what are the important factors that will influence you acceptance of any medically related software?

____

____

____

____

____

THANK YOU FOR YOUR TIME AND VALUABLE ANSWER

Appendix C

Complete Results of Analyses by WarpPLS 3.0

```
********************************
* General SEM analysis results *
********************************
```

General project information

Version of WarpPLS used: 3.0
Project path (directory): C:\Users\afreena\Desktop\
Project file: New_analysis.prj
Last changed: 07-Mar-2012 22:59:46
Last saved: Never (needs to be saved)
Raw data path (directory):
F:\AnalysisAfterOutliersJuly15th\FinalAnalysis-Oct2011\
Raw data file: RawData-may2011-2.xls

Model fit indices and P values

APC=0.401, P<0.001
ARS=0.193, P=0.002
AVIF=1.280, Good if < 5

General model elements

Algorithm used in the analysis: Warp3 PLS regression
Resampling method used in the analysis: Jackknifing
Number of data resamples used: 100
Number of cases (rows) in model data: 102
Number of latent variables in model: 11
Number of indicators used in model: 42
Number of iterations to obtain estimates: 7
Range restriction variable type: None
Range restriction variable: None
Range restriction variable min value: 0.000
Range restriction variable max value: 0.000
Only ranked data used in analysis? No

```
**********************************
* Path coefficients and P values *
**********************************
```

Path coefficients

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE	0.336										
EE	0.405										
SI	-0.366										

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
FC	0.410										
ISE	0.483										
MS	0.448										
SWQ	0.516										
IQ	0.318										
SERQ	0.466										
ITU						0.230	0.429				

P values

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE	<0.001										
EE	<0.001										
SI	<0.001										
FC	<0.001										
ISE	<0.001										
MS	<0.001										
SWQ	<0.001										
IQ	0.003										
SERQ	<0.001										
ITU						0.033	<0.001				

****
* Standard errors for path coefficients *
****

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE	0.087										
EE	0.097										
SI	0.095										
FC	0.068										
ISE	0.102										
MS	0.120										
SWQ	0.072										
IQ	0.115										
SERQ	0.081										
ITU						0.123	0.131				

****
* Effect sizes for path coefficients *
****

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE	0.113										
EE	0.164										
SI	0.134										
FC	0.168										
ISE	0.233										

```
MS    0.201
SWQ   0.266
IQ    0.101
SERQ  0.217
ITU                             0.099 0.230


***************************************
* Combined loadings and cross-loadings *
***************************************

      PUTOF PE    EE    SI    FC    ISE   MS    SWQ   IQ    SERQ  ITU   SE
      P value
PUTO_F6     0.649 0.056 0.042 -0.037      0.028 -0.059      -0.168
      0.469 -0.024      0.139 -0.051      0.084 <0.001
PUTO_F5     0.717 0.076 0.044 -0.014      -0.018      -0.049      -0.126
      -0.303      0.202 0.189 0.003 0.085 <0.001
PUTO_F1     0.671 0.023 0.114 0.178 0.014 -0.046      0.113 0.477 -0.109
      -0.339      -0.286      0.090 <0.001
PUTO_F2     0.784 -0.068      -0.035      -0.098      0.067 0.204 0.186 -
0.396 -0.091      -0.077      0.039 0.058 <0.001
PUTO_F3     0.775 0.065 -0.199      -0.043      -0.150      -0.177
      0.130 -0.036      0.010 0.109 0.153 0.072 <0.001
PUTO_F4     0.496 -0.210      0.094 0.050 0.098 0.165 -0.246      -0.138
      0.016 -0.043      0.149 0.110 <0.001
PE1   0.089 0.861 0.126 -0.075      -0.162      -0.058      0.042 -0.230
      0.141 -0.008      0.042 0.078 <0.001
PE2   -0.086      0.719 0.236 -0.008      0.030 0.083 0.321 -0.152      -
0.108 0.023 -0.379      0.093 <0.001
PE3   -0.131      0.756 -0.232      0.049 0.119 -0.017      -0.106
      0.137 -0.197      0.092 0.156 0.089 <0.001
PE4   0.117 0.724 -0.143      0.045 0.039 0.003 -0.257      0.282 0.146 -
0.110 0.163 0.113 <0.001
EE1   -0.122      -0.253      0.742 -0.146      -0.136      0.176 -0.252
      0.216 0.188 -0.121      0.108 0.124 <0.001
EE2   0.010 0.180 0.813 0.247 -0.123      0.171 0.356 -0.203      -0.253
      0.036 -0.088      0.086 <0.001
EE3   -0.059      0.159 0.804 0.058 -0.031      0.096 0.088 0.063 -0.129
      0.047 -0.120      0.089 <0.001
EE4   0.184 -0.123      0.708 -0.196      0.319 -0.491      -0.245      -
0.064 0.240 0.031 0.124 0.083 <0.001
SI1   -0.093      -0.143      -0.051      0.829 0.077 -0.017      0.010 -
0.079 0.079 0.160 0.058 0.076 <0.001
SI2   0.083 0.072 0.027 0.912 -0.033      0.006 -0.083      0.110 0.024 -
0.194 -0.031      0.068 <0.001
SI3   0.002 0.057 0.020 0.918 -0.037      0.009 0.073 -0.038      -0.095
      0.048 -0.021      0.073 <0.001
FC1   -0.095      -0.136      -0.075      0.029 0.796 -0.054      -0.334
      0.053 0.068 0.139 0.149 0.096 <0.001
FC2   0.046 0.075 -0.225      -0.116      0.759 0.100 0.424 -0.125      -
0.102 0.201 0.070 0.096 <0.001
FC3   0.054 0.067 0.303 0.085 0.762 -0.044      -0.073      0.069 0.030 -
0.345 -0.225      0.086 <0.001
```

```
ISE1  0.209 -0.051      0.054 0.055 0.582 0.656 -0.467      0.098 0.427 -
0.020 -0.261      0.139 <0.001
ISE2  -0.020      -0.123      -0.054      0.044 -0.051      0.653 -0.535
      -0.204      0.238 0.341 0.271 0.176 <0.001
ISE3  -0.218      0.076 -0.084      -0.117      -0.185      0.754 0.286
      0.324 -0.358      -0.001      -0.143      0.089 <0.001
ISE4  0.058 0.082 0.092 0.034 -0.305      0.685 0.642 -0.256      -0.241
      -0.305      0.149 0.133 <0.001
MS1   -0.066      -0.133      0.136 0.103 0.033 0.328 0.674 -0.366      -
0.323 0.242 -0.266      0.115 <0.001
MS2   0.061 0.017 0.129 -0.060      0.096 -0.166      0.749 -0.007
      0.309 -0.319      0.074 0.096 <0.001
MS3   0.130 -0.075      0.025 -0.075      0.021 -0.217      0.791 0.073
      0.119 0.168 0.035 0.066 <0.001
MS4   -0.167      0.219 -0.334      0.056 -0.177      0.121 0.622 0.313 -
0.174 -0.091      0.155 0.114 <0.001
SWQ1  0.064 0.039 0.174 0.010 -0.262      -0.027      0.043 0.659 0.423 -
0.160 0.062 0.099 <0.001
SWQ2  -0.019      -0.108      0.091 -0.120      0.250 0.118 -0.269
      0.691 -0.302      0.197 0.095 0.105 <0.001
SWQ3  0.070 0.054 -0.284      0.012 -0.017      -0.123      0.103 0.800 -
0.116 0.042 -0.035      0.070 <0.001
SWQ4  -0.115      0.008 0.067 0.091 0.019 0.047 0.101 0.740 0.031 -0.086
      -0.107      0.100 <0.001
IQ1   0.074 -0.010      0.094 -0.069      0.209 -0.042      -0.104      -
0.040 0.830 -0.245      -0.067      0.117 <0.001
IQ2   0.141 0.040 -0.130      -0.096      -0.021      -0.061      -0.190
      -0.266      0.743 0.254 0.021 0.074 <0.001
IQ3   -0.210      -0.027      0.024 0.163 -0.200      0.102 0.288 0.293
      0.790 0.018 0.051 0.095 <0.001
SERQ1 -0.054      0.068 -0.022      -0.070      -0.011      0.180 0.007 -
0.207 -0.090      0.738 0.040 0.097 <0.001
SERQ4 -0.024      -0.038      -0.047      0.147 0.006 0.109 0.182 0.250 -
0.288 0.804 -0.170      0.072 <0.001
SERQ2 0.075 -0.025      0.069 -0.084      0.005 -0.279      -0.191      -
0.061 0.377 0.791 0.136 0.110 <0.001
ITU1  -0.050      -0.103      -0.001      0.066 0.115 0.216 -0.009      -
0.190 0.066 -0.212      0.780 0.109 <0.001
ITU2  0.095 0.012 -0.011      -0.088      0.044 -0.163      0.062 0.032 -
0.027 -0.072      0.815 0.077 <0.001
ITU3  -0.039      0.051 0.107 0.059 -0.341      0.275 0.178 0.179 -0.110
      -0.051      0.743 0.110 <0.001
ITU4  -0.013      0.044 -0.094      -0.032      0.173 -0.323      -0.237
      -0.015      0.070 0.352 0.743 0.079 <0.001
```

Note: P values < 0.05 are desirable for reflective indicators.

```
***************************************
* Pattern loadings and cross-loadings *
***************************************

      PUTOF PE    EE    SI    FC    ISE   MS    SWQ   IQ    SERQ  ITU
```

PUTO_F6	0.404	0.056	0.042	-0.037	0.028	-0.059	-0.168	0.469	-0.024	0.139	-0.051
PUTO_F5	0.787	0.076	0.044	-0.014	-0.018	-0.049	-0.126	-0.303	0.202	0.189	0.003
PUTO_F1	0.668	0.023	0.114	0.178	0.014	-0.046	0.113	0.477	-0.109	-0.339	-0.286
PUTO_F2	0.859	-0.068	-0.035	-0.098	0.067	0.204	0.186	-0.396	-0.091	-0.077	0.039
PUTO_F3	0.821	0.065	-0.199	-0.043	-0.150	-0.177	0.130	-0.036	0.010	0.109	0.153
PUTO_F4	0.527	-0.210	0.094	0.050	0.098	0.165	-0.246	-0.138	0.016	-0.043	0.149
PE1	0.089	0.853	0.126	-0.075	-0.162	-0.058	0.042	-0.230	0.141	-0.008	0.042
PE2	-0.086	0.761	0.236	-0.008	0.030	0.083	0.321	-0.152	-0.108	0.023	-0.379
PE3	-0.131	0.800	-0.232	0.049	0.119	-0.017	-0.106	0.137	-0.197	0.092	0.156
PE4	0.117	0.645	-0.143	0.045	0.039	0.003	-0.257	0.282	0.146	-0.110	0.163
EE1	-0.122	-0.253	0.793	-0.146	-0.136	0.176	-0.252	0.216	0.188	-0.121	0.108
EE2	0.010	0.180	0.776	0.247	-0.123	0.171	0.356	-0.203	-0.253	0.036	-0.088
EE3	-0.059	0.159	0.717	0.058	-0.031	0.096	0.088	0.063	-0.129	0.047	-0.120
EE4	0.184	-0.123	0.797	-0.196	0.319	-0.491	-0.245	-0.064	0.240	0.031	0.124
SI1	-0.093	-0.143	-0.051	0.778	0.077	-0.017	0.010	-0.079	0.079	0.160	0.058
SI2	0.083	0.072	0.027	0.928	-0.033	0.006	-0.083	0.110	0.024	-0.194	-0.031
SI3	0.002	0.057	0.020	0.948	-0.037	0.009	0.073	-0.038	-0.095	0.048	-0.021
FC1	-0.095	-0.136	-0.075	0.029	0.960	-0.054	-0.334	0.053	0.068	0.139	0.149
FC2	0.046	0.075	-0.225	-0.116	0.451	0.100	0.424	-0.125	-0.102	0.201	0.070
FC3	0.054	0.067	0.303	0.085	0.897	-0.044	-0.073	0.069	0.030	-0.345	-0.225
ISE1	0.209	-0.051	0.054	0.055	0.582	0.219	-0.467	0.098	0.427	-0.020	-0.261
ISE2	-0.020	-0.123	-0.054	0.044	-0.051	0.690	-0.535	-0.204	0.238	0.341	0.271
ISE3	-0.218	0.076	-0.084	-0.117	-0.185	0.954	0.286	0.324	-0.358	-0.001	-0.143
ISE4	0.058	0.082	0.092	0.034	-0.305	0.848	0.642	-0.256	-0.241	-0.305	0.149
MS1	-0.066	-0.133	0.136	0.103	0.033	0.328	0.932	-0.366	-0.323	0.242	-0.266
MS2	0.061	0.017	0.129	-0.060	0.096	-0.166	0.646	-0.007	0.309	-0.319	0.074
MS3	0.130	-0.075	0.025	-0.075	0.021	-0.217	0.586	0.073	0.119	0.168	0.035

```
MS4   -0.167      0.219 -0.334      0.056 -0.177      0.121 0.728 0.313 -
0.174 -0.091      0.155
SWQ1  0.064 0.039 0.174 0.010 -0.262      -0.027      0.043 0.400 0.423 -
0.160 0.062
SWQ2  -0.019      -0.108      0.091 -0.120      0.250 0.118 -0.269
      0.707 -0.302      0.197 0.095
SWQ3  0.070 0.054 -0.284      0.012 -0.017      -0.123      0.103 0.995 -
0.116 0.042 -0.035
SWQ4  -0.115      0.008 0.067 0.091 0.019 0.047 0.101 0.745 0.031 -0.086
      -0.107
IQ1   0.074 -0.010      0.094 -0.069      0.209 -0.042      -0.104      -
0.040 0.968 -0.245      -0.067
IQ2   0.141 0.040 -0.130      -0.096      -0.021      -0.061      -0.190
      -0.266      0.957 0.254 0.021
IQ3   -0.210      -0.027      0.024 0.163 -0.200      0.102 0.288 0.293
      0.443 0.018 0.051
SERQ1 -0.054      0.068 -0.022      -0.070      -0.011      0.180 0.007 -
0.207 -0.090      0.808 0.040
SERQ4 -0.024      -0.038      -0.047      0.147 0.006 0.109 0.182 0.250 -
0.288 0.743 -0.170
SERQ2 0.075 -0.025      0.069 -0.084      0.005 -0.279      -0.191      -
0.061 0.377 0.788 0.136
ITU1  -0.050      -0.103      -0.001      0.066 0.115 0.216 -0.009      -
0.190 0.066 -0.212      0.858
ITU2  0.095 0.012 -0.011      -0.088      0.044 -0.163      0.062 0.032 -
0.027 -0.072      0.803
ITU3  -0.039      0.051 0.107 0.059 -0.341      0.275 0.178 0.179 -0.110
      -0.051      0.606
ITU4  -0.013      0.044 -0.094      -0.032      0.173 -0.323      -0.237
      -0.015      0.070 0.352 0.812


*****************************************
* Structure loadings and cross-loadings *
*****************************************

      PUTOF PE    EE    SI    FC    ISE   MS    SWQ   IQ    SERQ  ITU
PUTO_F6     0.649 0.296 0.420 -0.032      0.310 0.390 0.400 0.564 0.352
      0.481 0.387
PUTO_F5     0.717 0.195 0.303 -0.091      0.224 0.356 0.293 0.307 0.276
      0.348 0.355
PUTO_F1     0.671 0.068 0.301 0.116 0.269 0.288 0.328 0.464 0.223 0.272
      0.242
PUTO_F2     0.784 0.048 0.207 -0.203      0.351 0.365 0.323 0.238 0.142
      0.208 0.343
PUTO_F3     0.775 0.205 0.254 -0.125      0.217 0.251 0.344 0.367 0.198
      0.328 0.402
PUTO_F4     0.496 -0.048      0.174 0.046 0.216 0.258 0.106 0.160 0.087
      0.141 0.257
PE1   0.177 0.861 0.316 -0.251      0.100 0.154 0.209 0.253 0.230 0.301
      0.363
PE2   0.070 0.719 0.313 -0.195      0.199 0.205 0.287 0.277 0.230 0.362
      0.152
```

PE3	0.053	0.756	0.133	-0.134	0.191	0.085	0.114	0.208	0.084	0.212	0.315
PE4	0.292	0.724	0.283	-0.087	0.254	0.270	0.256	0.410	0.321	0.284	0.429
EE1	0.255	0.129	0.742	-0.006	0.149	0.401	0.310	0.451	0.351	0.385	0.337
EE2	0.311	0.315	0.813	0.139	0.239	0.385	0.435	0.447	0.297	0.548	0.373
EE3	0.289	0.352	0.804	0.026	0.231	0.372	0.411	0.494	0.341	0.519	0.329
EE4	0.379	0.239	0.708	-0.100	0.317	0.236	0.315	0.375	0.242	0.360	0.416
SI1	-0.091	-0.255	0.024	0.829	0.034	0.025	0.011	0.071	0.120	0.075	-0.027
SI2	-0.058	-0.180	-0.010	0.912	-0.068	-0.060	-0.126	0.083	0.054	-0.069	-0.045
SI3	-0.078	-0.160	0.052	0.918	-0.033	-0.047	-0.032	0.081	0.044	0.054	-0.046
FC1	0.231	0.100	0.168	0.060	0.796	0.406	0.305	0.288	0.260	0.244	0.340
FC2	0.400	0.301	0.277	-0.164	0.759	0.498	0.606	0.433	0.406	0.461	0.407
FC3	0.262	0.151	0.261	0.037	0.762	0.355	0.331	0.300	0.253	0.171	0.274
ISE1	0.371	0.096	0.269	0.090	0.549	0.656	0.292	0.381	0.486	0.360	0.192
ISE2	0.239	0.080	0.270	0.079	0.263	0.653	0.115	0.252	0.399	0.345	0.274
ISE3	0.273	0.243	0.342	-0.136	0.350	0.754	0.441	0.495	0.427	0.461	0.250
ISE4	0.389	0.199	0.369	-0.102	0.340	0.685	0.470	0.380	0.398	0.342	0.401
MS1	0.233	0.000	0.320	0.039	0.369	0.365	0.674	0.335	0.329	0.478	0.108
MS2	0.362	0.258	0.365	-0.086	0.438	0.330	0.749	0.508	0.533	0.358	0.412
MS3	0.440	0.237	0.430	-0.077	0.418	0.388	0.791	0.581	0.521	0.553	0.404
MS4	0.198	0.298	0.239	-0.028	0.280	0.299	0.622	0.449	0.372	0.340	0.329
SWQ1	0.338	0.291	0.443	0.059	0.182	0.392	0.459	0.659	0.540	0.435	0.370
SWQ2	0.431	0.258	0.482	-0.019	0.437	0.455	0.419	0.691	0.311	0.487	0.429
SWQ3	0.412	0.286	0.331	0.065	0.332	0.335	0.534	0.800	0.416	0.465	0.328
SWQ4	0.294	0.240	0.433	0.145	0.318	0.433	0.505	0.740	0.469	0.486	0.301
IQ1	0.266	0.202	0.288	0.014	0.401	0.501	0.463	0.441	0.830	0.326	0.263
IQ2	0.253	0.243	0.234	-0.028	0.251	0.452	0.406	0.358	0.743	0.404	0.211
IQ3	0.217	0.220	0.426	0.201	0.275	0.511	0.604	0.606	0.790	0.545	0.327
SERQ1	0.281	0.341	0.404	-0.080	0.252	0.404	0.428	0.380	0.339	0.738	0.260
SERQ4	0.347	0.203	0.467	0.139	0.325	0.450	0.524	0.595	0.392	0.804	0.230
SERQ2	0.379	0.340	0.515	-0.020	0.300	0.430	0.473	0.523	0.518	0.791	0.388
ITU1	0.318	0.191	0.264	0.020	0.405	0.357	0.249	0.255	0.262	0.152	0.780
ITU2	0.438	0.331	0.352	-0.134	0.341	0.248	0.368	0.360	0.212	0.250	0.815
ITU3	0.411	0.376	0.505	0.019	0.256	0.427	0.453	0.543	0.379	0.443	0.743
ITU4	0.322	0.378	0.340	-0.036	0.354	0.223	0.310	0.357	0.201	0.327	0.743

```
*********************
* Indicator weights *
*********************

      PUTOF PE    EE    SI    FC    ISE   MS    SWQ   IQ    SERQ  ITU   SE
      P value     VIF
PUTO_F6     0.228 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.029 <0.001      1.390
PUTO_F5     0.252 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.030 <0.001      1.473
PUTO_F1     0.236 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.031 <0.001      1.430
PUTO_F2     0.275 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.025 <0.001      1.875
PUTO_F3     0.272 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.028 <0.001      1.757
PUTO_F4     0.174 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.000 0.039 <0.001      1.234
PE1   0.000 0.366 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.036 <0.001      2.180
PE2   0.000 0.305 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.043 <0.001      1.702
PE3   0.000 0.321 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.032 <0.001      1.598
PE4   0.000 0.308 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.052 <0.001      1.461
EE1   0.000 0.000 0.314 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.028 <0.001      1.411
EE2   0.000 0.000 0.345 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.047 <0.001      1.708
EE3   0.000 0.000 0.341 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.043 <0.001      1.681
EE4   0.000 0.000 0.300 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.051 <0.001      1.343
SI1   0.000 0.000 0.000 0.351 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.036 <0.001      1.731
SI2   0.000 0.000 0.000 0.386 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.030 <0.001      2.969
SI3   0.000 0.000 0.000 0.389 0.000 0.000 0.000 0.000 0.000 0.000 0.000
      0.028 <0.001      3.069
FC1   0.000 0.000 0.000 0.000 0.444 0.000 0.000 0.000 0.000 0.000 0.000
      0.052 <0.001      1.336
FC2   0.000 0.000 0.000 0.000 0.424 0.000 0.000 0.000 0.000 0.000 0.000
      0.056 <0.001      1.268
FC3   0.000 0.000 0.000 0.000 0.426 0.000 0.000 0.000 0.000 0.000 0.000
      0.050 <0.001      1.274
ISE1  0.000 0.000 0.000 0.000 0.000 0.346 0.000 0.000 0.000 0.000 0.000
      0.070 <0.001      1.181
ISE2  0.000 0.000 0.000 0.000 0.000 0.345 0.000 0.000 0.000 0.000 0.000
      0.072 <0.001      1.170
ISE3  0.000 0.000 0.000 0.000 0.000 0.398 0.000 0.000 0.000 0.000 0.000
      0.081 <0.001      1.296
```

ISE4	0.000	0.000	0.000	0.000	0.000	0.362	0.000	0.000	0.000	0.000	0.000	0.086	<0.001		1.202
MS1	0.000	0.000	0.000	0.000	0.000	0.000	0.332	0.000	0.000	0.000	0.000	0.046	<0.001		1.245
MS2	0.000	0.000	0.000	0.000	0.000	0.000	0.370	0.000	0.000	0.000	0.000	0.051	<0.001		1.343
MS3	0.000	0.000	0.000	0.000	0.000	0.000	0.390	0.000	0.000	0.000	0.000	0.049	<0.001		1.435
MS4	0.000	0.000	0.000	0.000	0.000	0.000	0.307	0.000	0.000	0.000	0.000	0.056	<0.001		1.198
SWQ1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.314	0.000	0.000	0.000	0.034	<0.001		1.237
SWQ2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.329	0.000	0.000	0.000	0.043	<0.001		1.325
SWQ3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.381	0.000	0.000	0.000	0.058	<0.001		1.533
SWQ4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.352	0.000	0.000	0.000	0.049	<0.001		1.366
IQ1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.445	0.000	0.000	0.038	<0.001		1.481
IQ2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.399	0.000	0.000	0.062	<0.001		1.272
IQ3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.423	0.000	0.000	0.057	<0.001		1.382
SERQ1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.406	0.000	0.056	<0.001		1.243
SERQ4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.442	0.000	0.058	<0.001		1.376
SERQ2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.435	0.000	0.045	<0.001		1.349
ITU1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.328	0.032	<0.001		1.595
ITU2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.343	0.046	<0.001		1.726
ITU3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.313	0.039	<0.001		1.433
ITU4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.312	0.046	<0.001		1.465

Note: P values < 0.05 and VIFs < 2.5 are desirable for formative indicators.

****
* Latent variable coefficients *
****

R-squared coefficients

PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
	0.113	0.164	0.134	0.168	0.233	0.201	0.266	0.101	0.217	0.329

Composite reliability coefficients

PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
0.841	0.850	0.852	0.917	0.816	0.782	0.803	0.815	0.831	0.821	0.854

Cronbach's alpha coefficients

PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
0.772	0.764	0.767	0.864	0.662	0.628	0.672	0.696	0.694	0.674	0.772

Average variances extracted

PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
0.474	0.588	0.590	0.787	0.597	0.474	0.507	0.525	0.622	0.606	0.594

Full collinearity VIFs

PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
1.656	1.474	1.869	1.180	1.758	2.366	2.690	2.749	2.307	2.369	1.783

Q-squared coefficients

PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
	0.104	0.167	0.120	0.168	0.232	0.206	0.272	0.105	0.219	0.333

****
* Correlations among latent variables *
****

Latent variable correlations

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF	0.689	0.193	0.399	-0.085	0.384	0.460	0.443	0.509	0.311	0.433	0.483
PE	0.193	0.767	0.341	-0.221	0.236	0.229	0.279	0.370	0.280	0.376	0.412
EE	0.399	0.341	0.768	0.025	0.303	0.456	0.482	0.576	0.402	0.595	0.471
SI	-0.085	-0.221	0.025	0.887	-0.027	-0.033	-0.057	0.088	0.080	0.021	-0.045
FC	0.384	0.236	0.303	-0.027	0.772	0.543	0.534	0.439	0.395	0.377	0.440
ISE	0.460	0.229	0.456	-0.033	0.543	0.688	0.486	0.553	0.620	0.550	0.405
MS	0.443	0.279	0.482	-0.057	0.534	0.486	0.712	0.663	0.624	0.612	0.446
SWQ	0.509	0.370	0.576	0.088	0.439	0.553	0.663	0.724	0.596	0.645	0.488
IQ	0.311	0.280	0.402	0.080	0.395	0.620	0.624	0.596	0.788	0.537	0.340
SERQ	0.433	0.376	0.595	0.021	0.377	0.550	0.612	0.645	0.537	0.778	0.376

ITU	0.483	0.412	0.471	-0.045	0.440	0.405	0.446	0.488	0.340	0.376	0.771

Note: Square roots of average variances extracted (AVE's) shown on diagonal.

P values for correlations

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF	1.000	0.052	<0.001	0.397	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
PE	0.052	1.000	<0.001	0.026	0.017	0.020	0.005	<0.001	0.004	<0.001	<0.001
EE	<0.001	<0.001	1.000	0.806	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SI	0.397	0.026	0.806	1.000	0.787	0.744	0.567	0.378	0.424	0.836	0.656
FC	<0.001	0.017	0.002	0.787	1.000	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
ISE	<0.001	0.020	<0.001	0.744	<0.001	1.000	<0.001	<0.001	<0.001	<0.001	<0.001
MS	<0.001	0.005	<0.001	0.567	<0.001	<0.001	1.000	<0.001	<0.001	<0.001	<0.001
SWQ	<0.001	<0.001	<0.001	0.378	<0.001	<0.001	<0.001	1.000	<0.001	<0.001	<0.001
IQ	0.001	0.004	<0.001	0.424	<0.001	<0.001	<0.001	<0.001	1.000	<0.001	<0.001
SERQ	<0.001	<0.001	<0.001	0.836	<0.001	<0.001	<0.001	<0.001	<0.001	1.000	<0.001
ITU	<0.001	<0.001	<0.001	0.656	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.000

****
* Block variance inflation factors *
****

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE											
EE											
SI											
FC											
ISE											
MS											
SWQ											
IQ											
SERQ											
ITU						1.280	1.280				

Notes:
- These VIFs are for the latent variables on each column (predictors), with reference to the latent variables on each row (criteria).

```
*****************************
* Indirect and total effects *
*****************************
```

Indirect effects for paths with 2 segments

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE											
EE											
SI											
FC											
ISE											
MS											
SWQ											
IQ											
SERQ											
ITU	0.304										

Number of paths with 2 segments

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE											
EE											
SI											
FC											
ISE											
MS											
SWQ											
IQ											
SERQ											
ITU	2										

P values of indirect effects for paths with 2 segments

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE											
EE											
SI											
FC											
ISE											
MS											
SWQ											
IQ											
SERQ											
ITU	<0.001										

Standard errors of indirect effects for paths with 2 segments

----

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE											
EE											
SI											
FC											
ISE											
MS											
SWQ											
IQ											
SERQ											
ITU	0.069										

Effect sizes of indirect effects for paths with 2 segments

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE											
EE											
SI											
FC											
ISE											
MS											
SWQ											
IQ											
SERQ											
ITU	0.156										

Sums of indirect effects

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE											
EE											
SI											
FC											
ISE											
MS											
SWQ											
IQ											
SERQ											
ITU	0.304										

Number of paths for indirect effects

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE											
EE											
SI											
FC											
ISE											
MS											

SWQ											
IQ											
SERQ											
ITU	2										

P values for sums of indirect effects

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE											
EE											
SI											
FC											
ISE											
MS											
SWQ											
IQ											
SERQ											
ITU	<0.001										

Standard errors for sums of indirect effects

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE											
EE											
SI											
FC											
ISE											
MS											
SWQ											
IQ											
SERQ											
ITU	0.069										

Effect sizes for sums of indirect effects

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE											
EE											
SI											
FC											
ISE											
MS											
SWQ											
IQ											
SERQ											
ITU	0.156										

Total effects

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU

PUTOF											
PE	0.336										
EE	0.405										
SI	-0.366										
FC	0.410										
ISE	0.483										
MS	0.448										
SWQ	0.516										
IQ	0.318										
SERQ	0.466										
ITU	0.304					0.230	0.429				

Number of paths for total effects

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE	1										
EE	1										
SI	1										
FC	1										
ISE	1										
MS	1										
SWQ	1										
IQ	1										
SERQ	1										
ITU	2					1	1				

P values for total effects

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE	<0.001										
EE	<0.001										
SI	<0.001										
FC	<0.001										
ISE	<0.001										
MS	<0.001										
SWQ	<0.001										
IQ	0.003										
SERQ	<0.001										
ITU	<0.001					0.033	<0.001				

Standard errors for total effects

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE	0.087										
EE	0.097										
SI	0.095										
FC	0.068										
ISE	0.102										
MS	0.120										
SWQ	0.072										

IQ	0.115										
SERQ	0.081										
ITU	0.069					0.123	0.131				

Effect sizes for total effects

	PUTOF	PE	EE	SI	FC	ISE	MS	SWQ	IQ	SERQ	ITU
PUTOF											
PE	0.113										
EE	0.164										
SI	0.134										
FC	0.168										
ISE	0.233										
MS	0.201										
SWQ	0.266										
IQ	0.101										
SERQ	0.217										
ITU	0.156					0.099	0.230				

Appendix D

Questionnaire 2

QUESTIONNAIRE_2

Understanding and Ranking of Factor Influence User Acceptance of Medical Related Software

Dear Participant,
My name is Noor Azizah KS Mohamadali, a postgraduate student at the School of Computer Science, University of Nottingham, United Kingdom. I am currently conducting a study on user acceptance of medical software which my dissertation will be about.

The purpose of this study is to obtain the ranking of factor influence user acceptance of medical software.

The eligibility requirement of the study is that you have used some software in your clinical work (or throughout/during your course of study, during placement, during medical practice etc) at some point in the last two years (it does not matter which software, or for how long you have used it). Or if you are at early stage of you study and believe at some point in future you will learn or use any medically related software, you are also eligible to participate in this study.

Please note that factors such as user's experience with the software, age and gender are measured as moderating factors in our study rather than as direct factors. These moderating factors, depending on the environment, may or may not have a direct effect on user acceptance of software technology, but the study will allow for this.

Based on your opinion, please **CHOOSE** appropriate answer(s). Your participation in this study is greatly appreciated. All the participants and answers will remain anonymous. Data collected from this study will be available solely for research purpose. Since NO personal information, such as your name or any other defining characteristics, are collected, this will NOT be included in ANY report, under ANY circumstances.

I will appreciate it if you could answer the questions as completely as possible. The questionnaire should take NO longer than 10 minutes of your time. Thanks in advance for your participation.

Regards,

Noor Azizah KS MOHAMADALI,
Phd candidate,
School of Computer Science,
University of Nottingham
mnk@cs.nott.ac.uk

Assoc. Prof. Jonathan M. Garibaldi
Supervisor,
School of Computer Science
University of Nottingham
jmg@cs.nott.ac.uk

THANK YOU FOR YOUR TIME AND VALUABLE ANSWER

Phone No: 0115 95 14229 **PhoneNo: +44 (0) 115 95 14216**

SECTION A: BACKGROUND INFORMATION

1. Gender: ❑ Male ❑ Female

2. Status / Role: ❑ Postgraduate Student ❑ Research Assistant ❑ Research Fellow
   ❑ Other: ____________________________

3. Age Range: ❑ < 20 years ❑ 20 – 29 years ❑ 30 – 39 years
   ❑ 40 – 49 years ❑ 50-59 years ❑ 60+ years

4. University / College: ____

5 School / Faculty / Center: ____

6. Department / Division: ____

7. Country: ____

8. Answer this question in relation to the medically related software that you use or learn the most.

   Name of the Software: ____

9. Do you think previous experience of using different software for the same purpose (s) is important in influencing acceptance?

   ❑ Yes ❑ No

10. Do you think gender will have some degree of influence in the use of software?

   ❑ Yes ❑ No

THANK YOU FOR YOUR TIME AND VALUABLE ANSWER

Ranking of User Acceptance by Pair-wise Comparison

Instruction:

Assuming you are currently using medically related software(s) or will use *any* medically related software(s) in future in your workplace, answer the following questions carefully.

Below are the lists of **CONSTRUCTS** which may influence user's acceptance of medically related software. Definitions of each **CONSTRUCT** are given below. Based on this definition, compare given constructs, each pair CAREFULLY in terms of their influence in your acceptance of the software, Then, decide how important is that construct compared to the other construct. Choose the appropriate answer which represents your opinion of the relative importance of the **CONSTRUCTS.**

Please Note: If you believe, the given pair is equally influencing/will influence your acceptance of the software; you MUST mark both boxes and mark 'equally important' option.

The definitions of the constructs are as follows:

INDIVIDUAL SUB-FACTOR	
Construct	**Definition**
Performance Expectancy	I believe by using the software (currently or in future), it increases and improves *(will)* my job performance/ medically related work.
Effort Expectancy	I believe the software is/needs to be easy to use
Social Influence	I use/will use the software because/if my colleagues are using it.
Information Security Expectancy	I believe the sensitive information will not be viewed, stored or manipulated by unauthorized person. Data confidentiality is preserved and the right levels of authorization to access data are given.

12.* Based on your experience/opinion, which one of these constructs has/will have more influence in your acceptance of the software?

- ❑ Performance Expectancy
- ❑ Effort Expectancy

13.* How important is this selected construct compared to the other construct?

- ❑ Absolutely More Important
- ❑ Much More Important
- ❑ More Important
- ❑ Slightly More Important
- ❑ Equally Important

14.* Compare these two construct. Which has / will have more influence in your acceptance of the software?

- ❑ Effort Expectancy
- ❑ Social Influence

THANK YOU FOR YOUR TIME AND VALUABLE ANSWER

15.* How important is this selected construct compared to the other construct?

- ❑ Absolutely More Important
- ❑ Much More Important
- ❑ More Important
- ❑ Slightly More Important
- ❑ Equally Important

16.* Compare these two construct. Which has / will have more influence in your acceptance of the software?

- ❑ Effort Expectancy
- ❑ Information Security Expectancy

17.* How important is this selected construct compared to the other construct?

- ❑ Absolutely More Important
- ❑ Much More Important
- ❑ More Important
- ❑ Slightly More Important
- ❑ Equally Important

18.* Compare these two construct. Which has / will have more influence in your acceptance of the software?

- ❑ Performance Expectancy
- ❑ Social Influence

19.* How important is this selected construct compared to the other construct?

- ❑ Absolutely More Important
- ❑ Much More Important
- ❑ More Important
- ❑ Slightly More Important
- ❑ Equally Important

20.* Compare these two construct. Which has / will have more influence in your acceptance of the software?

- ❑ Social Influence
- ❑ Information Security Expectancy

21.* How important is this selected construct compared to the other construct?

- ❑ Absolutely More Important
- ❑ Much More Important
- ❑ More Important
- ❑ Slightly More Important
- ❑ Equally Important

22.* Compare these two construct. Which has / will have more influence in your acceptance of the software?

- ❑ Performance Expectancy
- ❑ Information Security Expectancy

23.* How important is this selected construct compared to the other construct?

- ❑ Absolutely More Important
- ❑ Much More Important
- ❑ More Important
- ❑ Slightly More Important
- ❑ Equally Important

THANK YOU FOR YOUR TIME AND VALUABLE ANSWER

TECHNOLOGY SUB-FACTOR

The definitions of the constructs are as follows:

TECHNOLOGY SUB-FACTOR	
Construct	**Definition**
Software Quality	The qualities of the software such as usability, availability, reliability, adaptability, response time, etc.
Information Quality	The qualities of the information produced by the software such as results are easy to understand, accurate, reports produced are of high quality, etc.
Service Quality	The qualities of support delivered by the software provider such as quick responses to the problems, 24-hours customer support service, etc.

24.* Based on your experience/opinion, which one of these constructs has/will have more influence in your acceptance of the software?

- ❑ Software Quality
- ❑ Service Quality

25.* How important is this selected construct compared to the other construct?

- ❑ Absolutely More Important
- ❑ Much More Important
- ❑ More Important
- ❑ Slightly More Important
- ❑ Equally Important

26.* Compare these two construct. Which has / will have more influence in your acceptance of the software?

- ❑ Software Quality
- ❑ Information Quality

27.* How important is this selected construct compared to the other construct?

- ❑ Absolutely More Important
- ❑ Much More Important
- ❑ More Important
- ❑ Slightly More Important
- ❑ Equally Important

28.* Compare these two construct. Which has / will have more influence in your acceptance of the software?

- ❑ Service Quality
- ❑ Information Quality

29.* How important is this selected construct compared to the other construct?

- ❑ Absolutely More Important
- ❑ Much More Important
- ❑ More Important
- ❑ Slightly More Important
- ❑ Equally Important

THANK YOU FOR YOUR TIME AND VALUABLE ANSWER

ORGANIZATION SUB-FACTOR

The definitions of the constructs are as follows:

ORGANIZATION SUB-FACTOR	
Construct	**Definition**
Facilitating Condition	The organization provides/needs to provide all the necessary facilities to enable me to use the software effectively and efficiently such as training, hardware, network infrastructure etc.
Management Support	Management provides/needs to provide a supportive working environment and encouragement to innovate and improve working practice.

30.* Based on your experience/opinion, which one of these constructs has/will have more influence in your acceptance of the software?

- ❑ Facilitating Condition
- ❑ Management Support

31.* How important is this selected construct compared to the other construct?

- ❑ Absolutely More Important
- ❑ Much More Important
- ❑ More Important
- ❑ Slightly More Important
- ❑ Equally Important

THANK YOU FOR YOUR TIME AND VALUABLE ANSWER

RANKING OF THE FACTORS

NOW CONSIDER THE FACTORS (GROUP OF CONSTRUCTS) TAKEN AS A WHOLE.

A. The term **'INDIVIDUAL FACTORS'** refer to the four constructs which **are performance expectancy, effort expectancy, social influence and information security expectancy.**

Performance Expectancy	I believe by using the software (currently or in future), it (will) increase and improves my job performance/ medically related work.
Effort Expectancy	I believe the software is/needs to be easy to use.
Social Influence	I use/will use the software because/if my colleagues are using it.
Information Security Expectancy	I believe the sensitive information will not be viewed, stored or manipulated by unauthorized person. Data confidentiality is preserved and right levels of authorization to access data are given.

B. The term **'TECHNOLOGY FACTORS'** refer to three constructs which are **software quality, information quality and service quality.**

Software Quality	The qualities of the software such as usability, availability, reliability, adaptability, response time etc.
Information Quality	The qualities of the information produced by the software such as results are easy to understand, accurate, reports produced are of high quality etc.
Service Quality	The qualities of support delivered by the software provider such as quick responses to the problems, 24-hour customer support service etc

The term **'ORGANIZATION FACTORS'** refer to two constructs which are **facilitating condition and management support.**

Facilitating Condition	The organization provides/needs to provide all the necessary facilities to enable me to use the software effectively and efficiently such as training, hardware, network infrastructure etc
Management Support	Management provides/needs to provide supportive working environment and encouragement to innovate and improve working practice *(through the use of the software).*

32.* Based on your experience/opinion, which one of these constructs has/will have more influence in your acceptance of the software?

- ❑ Individual Factor
- ❑ Technology Factor

33.* How important is this selected construct compared to the other construct?

- ❑ Absolutely More Important
- ❑ Much More Important
- ❑ More Important
- ❑ Slightly More Important
- ❑ Equally Important

THANK YOU FOR YOUR TIME AND VALUABLE ANSWER

34.* Based on your experience/opinion, which one of these constructs has/will have more influence in your acceptance of the software?

- ❑ Individual Factor
- ❑ Organization Factor

35.* How important is this selected construct compared to the other construct?

- ❑ Absolutely More Important
- ❑ Much More Important
- ❑ More Important
- ❑ Slightly More Important
- ❑ Equally Important

36.* Based on your experience/opinion, which one of these constructs has/will have more influence in your acceptance of the software?

- ❑ Technology Factor
- ❑ Organization Factor

37.* How important is this selected construct compared to the other construct?

- ❑ Absolutely More Important
- ❑ Much More Important
- ❑ More Important
- ❑ Slightly More Important
- ❑ Equally Important

===

PART 2: Ranking of the Sub-Factors without Comparison

In this section, you will indicate the importance of each construct/factor which influences/may influence your acceptance of the software. This time, you are rating each construct individually without making any comparison. Mark the appropriate column which represents exactly your opinion of the construct.

Performance Expectancy	I believe by using the software (currently or in future), it increases and improves (will) my job performance/ medically related work.
Effort Expectancy	I believe the software is/needs to be easy to use.
Social Influence	I use/will use the software because/if my colleagues are using it.
Information Security Expectancy	I believe the sensitive information will not be viewed, stored or manipulated by unauthorized person. Data confidentiality is preserved and right levels of authorization to access data are given.

38.* Level of Importance

	Extremely Important	Very Important	Important	Slightly Important	Not Important
Performance Expectancy	○	○	○	○	○
Effort Expectancy	○	○	○	○	○
Social Influence	○	○	○	○	○
Information Security Expectancy	○	○	○	○	○

THANK YOU FOR YOUR TIME AND VALUABLE ANSWER

Mark the appropriate column which represents exactly your opinion of the construct. This time, you are rating each construct individually without making any comparison

Software Quality	The qualities of the software such as usability, availability, reliability, adaptability, response time etc.
Service Quality	The qualities of support delivered by the software provider such as quick responses to the problems, 24-hours customer support service etc.
Information Quality	The qualities of the information produced by the software such as results are easy to understand, accurate, reports produced are of high quality etc.
Facilitating Condition	The organization provides/needs to provide all the necessary facilities to enable me to use the software effectively and efficiently such as training, hardware, network infrastructure etc.
Management Support	Management provides/needs to provide supportive working environment and encouragement to innovate and improve working practice.

39.* Level of Importance

	Extremely Important	Very Important	Important	Slightly Important	Not Important
Software Quality					
Service Quality					
Information Quality					
Facilitating Condition					
Management Support					

RANKING OF THE FACTOR WITHOUT COMPARISION

Individual Factor	This factor consists of performance expectancy, effort expectancy, social influence and information security expectancy.
Technology Factor	This factor consists of software quality, service quality and information quality.
Organization Factor	This factor consists of facilitating condition and management support.

40. * Level of Importance

	Extremely Important	Very Important	Important	Slightly Important	Not Important
Individual Factor					
Technology Factor					
Organization Factor					

THANK YOU FOR YOUR TIME AND VALUABLE ANSWER