CRANFIELD UNIVERSITY

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A Model on Factors Affecting Nurses Adoption of Health Information Technology

School of Aerospace, Transport and Manufacturing (SATM)

Doctor of Philosophy
Academic Year: 2016 - 2017

Supervisor: Ip-Shing Fan
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This thesis is submitted in partial fulfilment of the requirements for the degree of PhD
(NB. This section can be removed if the award of the degree is based solely on examination of the thesis)

ABSTRACT

Healthcare organisations are using Health Information Technology (HIT) to improve efficiency, reduce cost and reduce medical errors. This study focused on the factors that influence the acceptance of HIT among nurses in Saudi hospitals.

This research used a 6 stage mixed-methods research approach. Literature was used to search for established models and frameworks of technology acceptance, and the many factors that could play a role. In the field study, the nature of practical HIT issues at the Prince Sultan Military Medical City (PSMMC) and the Heraa Hospital were studied, and combined with literature to create a HIT Implementation Issues Framework. The framework consolidates elements from the Technological, Organisational, Environmental and Human dimensions.

The researcher participated in further PSMMC projects in the design and implementation of the new Cardio Pulmonary Resuscitation System and the Nurses and Pharmacists' Communication System. From the implementation experience, pertinent factors were added to the Technology Acceptance Model and the "Nurses Acceptance Model" was proposed. The proposed model has eleven independent parameters, two dependent parameters, as well as seven moderators of key relationships. A questionnaire with 71 entries was distributed to over 2800 nurses in 52 wards in PSMMC. SPSS was used for data screening and descriptive statistics. The SmartPLS software was used for analysis and testing of the proposed hypotheses. The findings refined the "Nurses Acceptance Model" and highlight the significance of User Involvement and Training.

The "Nurses Acceptance Model" enhances the scientific understanding of variables that affect technology acceptance among nurses in Saudi hospitals. The HIT Implementation Issues Framework helps hospital decision makers to plan HIT projects to improve the likelihood of successful adoption.

Keywords:

TAM3 model, TOE framework, Nurses, Critical Factor, Barriers, communication, CPR, CDSS, CPOE and Saudi Arabia.

LIST OF PUBLICATIONS

- Almeziny M, Binobaid S, Fan I (2018) Reducing time and potential errors in CPR medications using a CPR calculator in paediatric wards. *23rd Annual Congress of the EAHP, 21st - 23rd March 2018, Gothenburg, Sweden*. **(Accepted Conference Paper).**
- Binobaid, S., Fan, I.-S. (2017) 'Nurses Acceptance of Health Information Technology' Annual Symposium - Rebooting the Role of Sociotechnical Perspectives in a hyper-connected, digitised society. *BCS Sociotechnical Specialist Group - Annual Symposium, 27th October 2017, London.* **(Presented Paper)**.
- Binobaid, S., Fan, I. and Almeziny, M. (2017) Reducing time and potential errors in CPR medications using a CPR calculator in paediatric wards. *Resuscitation*. **(Submitted Paper).**
- Almeziny M, Binobaid S, Fan I (2017) GM-022 Using an integrated information system to reduce interruptions and the number of non-relevant contacts in the inpatient pharmacy at a tertiary hospital. *Eur J Hosp Pharm* 2017;24:A167-A168. (**Published Abstract**)
- Binobaid, S., Almeziny, M. and Fan, I.-S. (2017) 'Using an integrated information system to reduce interruptions and the number of non-relevant contacts in the inpatient pharmacy at tertiary hospital', *Saudi Pharmaceutical Journal*, 25(5), pp. 760–769. *Saudi Pharmaceutical Journal*. (**Published Paper**).
- Binobaid, S., Fan, I.-S. and Almeziny, M. (2016) 'Investigation Interoperability Problems in Pharmacy Automation: A Case Study in Saudi Arabia', *Procedia Computer Science*, 100, pp. 329–338. **(Published Paper).**
- S. Binobaid, I. Fan (2012) 'Business Intelligence and Enterprise Interoperability: Literature Review', *I-ESA'12 (Interoperability for Enterprise Systems and Applications) Conference, 22-23 March 2012, Valencia, Spain*. **(Published Paper).**

ACKNOWLEDGEMENTS

I thank Almighty God (*Allah*), the source of mercy, grace, and power, for giving me the strength, determination and capacity to accomplish my thesis. My sincere thank goes to many people who contributed in the achievement route of this study.

First and foremost, I owe my deep and sincere gratitude to my dear supervisor Dr Ip-Shing Fan. His support and guidance with understanding, encouragement and patience have motivated me through the demanding process of completing this thesis. I am indebted to him for the time and effort invested in assisting me to develop and refine my research. Thanks also extended to Dr. Mohammed Almuzaini the head of pharmacy in PSMMC for his endless help, and support during the whole project work and the case study implantation, he has paved the way for me to implement my project successfully. My gratitude also goes to Professor Said Al-Gahtani who offered great help in building the study model in addition to his valuable advices. I am also grateful to his instruments validating and donating his time to improve my work.

I am also obliged to the hospital administration and staff for agreeing to host this study and their cooperation throughout the period of my project. Without them, this research would never have been possible.

I cannot forget to thank all my supportive Cranfield colleagues; one could not pray for better ones. They have offered help during this long process of finishing my research, whether by offering all kinds of professional advice and assistances or in reading and commenting on my work. As well as, a special and superior appreciation goes to my friend, Abdullah Alharthy for his valued suggestions and insightful comments, knowing him was a worthwhile experience and a God bless.

Last but not least, all gratefulness goes to my wonderful parents, whom I cherish the most, for their unconditional love, continuous support, belief and limitless sacrifices. They were the most passionate supporter throughout this work time. Their wholehearted constant prayers and encouragements have moved me to overcome all obstacles through the road to the completion of this thesis. Without their sympathy and willingness to listen to my endless grievances, I could not have come this far. For years, their steady care, and energetic talks will be always remembered. I would like also to express thanks to my siblings and my aunt Fatimah for their support and care. Most of all, my deepest appreciation goes to my wife. Her support, compassion, understanding and cooperation assured my success.

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LIST OF ABBREVIATIONS

ADCs	Automated Medication Dispensing Cabinets
ADEs	Adverse Drug Events
ADRs	Adverse Drug Reactions
BI	Behavioural Intention
CANX	Computer Anxiety
CDSS	Clinical Decision Support System
CPLAY	Computer Playfulness
CPOE	Computerised Physician Order Entry
CPR	CardioPulmonary Resuscitation
CSE	Computer Self-Efficacy
HER	Electronic Health Records
EXP	Experience
ENJ	Perceived Enjoyment
HIT	Health Information Technology
IMG	Image
IS	Information Systems
IT	Information Technology
KAU-HS	King Saud bin Abdul Aziz University for Health Sciences
KFSH & RC	King Faisal Specialist Hospital and the Research Centre
KSA	Kingdom of Saudi Arabia
MRS	Medical Records System
NGHA	National Guard Hospitals
OUT	Output Quality
PCCU	Paediatric Critical Care Unit
PEOU	Perceived Usefulness
PEC	Perception of External Control
PLS-SEM	Partial Least Squares-Structural Equation Modelling
PU	Perceived Ease of Use
PSMMC	Prince Sultan Military Medical City
REL	Job Relevance
RES	Result Demonstrability
SN	Subjective Norm
UI	User Involvement
UT	User Training
UTAUT	Unified Theory of Acceptance and Use of Technology
USE	Use Behaviour
VOL	Voluntariness

GLOSSARY - TECHNOLOGY ACCEPTANCE MODEL

Behavioural intention	The degree to which a person has formulated conscious plans to perform or not perform some specified future behaviour (Davis, 1989).
Computer Playfulness	"... the degree of cognitive spontaneity in microcomputer interactions" (Webster and Martocchio, 1992, p. 204).
Computer anxiety	The degree of "an individual's apprehension, or even fear, when she/he is faced with the possibility of using computers" (Venkatesh, 2000, p. 349).
Computer Self-Efficacy	The degree to which an individual believes that he or she has the ability to perform a specific task/job using the computer (Compeau and Higgins, 1995a, 1995b).
Image	The degree to which an individual perceives that use of an innovation will enhance his or her status in his or her social system (Moore and Benbasat, 1991).
Job Relevance	The degree to which an individual believes that the target system is applicable to his or her job (Venkatesh and Davis, 2000).
Output Quality	The degree to which an individual believes that the system performs his or her job tasks well (Venkatesh and Davis, 2000).
Perceived Ease of Use	The degree to which a person believes that using an IT will be free of effort (Davis, 1989).
Perceived Enjoyment	The extent to which "the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use" (Venkatesh, 2000, p. 351).
Perceived Usefulness	The degree to which a person believes that using a particular system would enhance his or her job performance (Davis, 1989).
Perception of External Control	The degree to which an individual believes that organizational and technical resources exist to support the use of the system (Venkatesh *et al.*, 2003).
Result Demonstrability	The degree to which an individual believes that the results of using a system are tangible, observable, and communicable (Moore and Benbasat, 1991).
Subjective Norm	The degree to which an individual perceives that most people who are important to him think he should or should

	not use the system (Fishbein and Ajzen, 1975; Venkatesh and Davis, 2000).
Voluntariness	The extent to which potential adopters perceive the adoption decision to be non-mandatory(Moore and Benbasat, 1991; Hartwick and Barki, 1994; Agarwal and Prasad, 1997).

1 Introduction

This chapter introduces the need of the research, the research aim, objectives and the thesis structure. After the research problems is described, the characteristics and significance of common medication errors and Health Information Technology (HIT) is presented. The Saudi Arabia healthcare and HIT as research context is explained. Then, the research aim, objectives, contribution are stated. Finally, the research process is presented within the overview of the thesis structure.

1.1 Research Problem

This thesis addresses the very important issue of ensuring long-term patient safety through proper Health Information Technology (HIT) implementation. The effects of poorly implemented HIT systems have been discussed in literature (Koppel *et al.*, 2005; Aarts, Ash and Berg, 2007). When systems are poorly implemented, the outcome could be higher medical error rates or errors that have not existed before the implementation, both can severely affect the quality of care and patient safety. Literature refers to these as “unintended consequences". Causes of unintended consequences have been linked to nurses’ poor understanding of systems and missed communication within the healthcare team (Aarts, Ash and Berg, 2007; Harrison, Koppel and Bar-Lev, 2007)..

The Kingdom of Saudi Arabia has invested heavily in its health system and boasts one of the most advanced medical service in the world. However, there has been repeated situations when IT systems were not used effectively in the hospitals. Nurses are on the frontline of medical care to the patients and make up the largest proportion of the workforce in hospitals. This research was initiated to advance the understanding of barriers, adoption and actual use of HIT among nurses in developing countries like Saudi Arabia.

The researcher has the opportunity to work with the HIT team in the Prince Sultan Military Medical City (PSMMC) to support business analysis during the doctoral study. The researcher was exposed to the multiple practical issues that led to previous HIT project failures and involved in new PSMMC initiatives.

1.2 Medication Errors

Hospitals and healthcare professionals aim to provide high quality and safe medical care to their patients. This includes safe and effective use of medications as well as minimising any potential errors. The definition of medication error varies widely in the literature (Lisby *et al.*, 2012; Alsulami, Conroy and Choonara, 2013; Salmasi *et al.*, 2015). The one by the National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) in the USA is the most common definition:

"Any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer. Such events may be related to professional practice, healthcare products, procedures, and systems, including: prescribing; order communication; product labelling, packaging, and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use." (NCCMERP, 2017).

The occurrence of medication errors is a major issue in general practice and in hospitals, by which potential harm to patients could be caused (Knudsen *et al.*, 2007; Velo and Minuz, 2009). In fact, the cost of solving problems caused by Adverse Drug Events (ADE) has been estimated as double the expenses spent on the medication used in diseases management. According to Ernst and Grizzle ADE's costed the USA about $177 billion annually and it was estimated that ADE's were the 4th to 6th most frequent cause of death in United States (Ernst and Grizzle, 2001). In Australia, about 3% of all hospitalised patients were admitted to hospitals because of medication errors (Roughead and Semple, 2009).

Medical errors could occur anywhere in the health care system, in the surgery centres, clinics, diagnosis, pharmacies and lab report (Ajami and Amini, 2013). Medication Errors occur mostly at the prescribing stage (ASHP, 2011). Studies showed that prescribing errors could be caused by multiple factors related to health professionals and health care systems (Qureshi *et al.*, 2009). They could be due to poorly written prescriptions, illegible or unclear handwriting (Qureshi *et* *al.*, 2009), mis-calculation or errors in unit expression, faults in patient identification, information in ordering forms. In transcribing and dispensing, the causes include interruptions during prescription, e.g. telephone calls, and problems in memory, such as memory lapses (Bates *et al.*, 1995; Dean *et al.*, 2002).

Other medical errors relate to the lack of interoperability among medical devices. Hospitals rely on medical devices for testing, monitoring and treating patients. Such devices may include infusion pumps, ventilators, pulse oximeters, blood pressure cuffs to electronic health records. Nurses believed that medical errors can be reduced if there is better interoperability among medical devices (Fetter, 2009). Specifically, half of the 526 full-time nurses surveyed for the report said that they had observed a medical error occurring because of a lack of coordination between medical devices in the hospital. The survey found that 41% of the nurses spend three or more hours per shift on tasks such as programming and setting up devices followed by data transcription. About 46 percent of respondents claimed that an error is very likely to occur when there is a manual transcription from one device to another.

In Saudi Arabia, a study indicated that prescribing errors affect 18.7% of all prescriptions, and the impact of these errors varies from minor to serious (Qureshi *et al.*, 2009). Another study examined medication prescribing errors in a paediatric inpatient tertiary care setting in Saudi Arabia. This study found that the overall medication prescribing error rate was 56 per 100 medication orders (Al-Jeraisy, Alanazi and Abolfotouh, 2011). In addition, another study by Dossari et al.,(2014) found that transcribing errors made up 49% of the total reported medication errors caused by communication breakdown between the physicians and nurses during the verbal order.

1.3 Health Information Technology (HIT)

The report “To Err Is Human: Building a Safer Health System” highlights the importance of safety as the first step in improving quality of care. The report revealed that between 44,000 and 98,000 Americans died every year because of medical errors. One of the main findings is that the majority of medical errors do not result from healthcare providers, but rather from poor systems which must be modified, upgraded and connected to support patient safety (*To Err Is Human*, 2000).

HIT as an integrated, comprehensive information system has been designed to control and manage all the hospital's operations like financial, administrative, medical, and legal; and provide the corresponding services (Haux, 2010). HIT when implemented and used properly has the potential to improve healthcare quality, efficiency, effectiveness, reduce or prevent medical errors, reduce healthcare costs; and provide up-to-date information to both providers and consumers, early detection and management of disease, and reduce storage cost (Ahlan and Ahmad, 2014). HIT can be implemented in different components such as Electronic Health Record (EHR), Computerised Physician/Provider Order Entry (CPOE), Clinical Decision Support System (CDSS). Hospitals has different levels of integration of different combinations of these systems.

1.4 Healthcare in Saudi Arabia: Background and Current Status

This research is sponsored by the Kingdom of Saudi Arabia(KSA). Healthcare has progressed rapidly in the Kingdom with heavy investment in the services as well as the transformation to localise staff.

1.4.1 Healthcare Systems in Saudi Arabia

The Kingdom of Saudi Arabia is the largest of the six Gulf Cooperation Council (GCC) countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates).

Saudi Arabia is also recognised as the fastest growing population in GCC. According to the country's Central Department of Statistics (2016), the population was 27.1 million in 2010 compared to 22.6 million in 2004. The population has reached 31.1 million in 2016, including 11.7 million non-Saudi. Saudi citizens comprise around 62.4% of the total population. According to the United Nations (2015), the population of Saudi Arabia is expected to reach 39.1 million by 2025 and 46.0 million by 2050.

Public healthcare in Saudi Arabia is currently free of charge to all Saudi citizens and expatriates working in the public sector. This is primarily provided by the Ministry of Health (MoH) (2015) which is the major government provider and the largest owner of healthcare services in the kingdom owning over 60% of all hospitals. These include 274 hospitals (41297 beds) and 2282 primary health care (PHC) centres. The MoH is responsible for managing, planning and formulating health policies and supervising health programmes, as well as monitoring health services in the private sector. It is also responsible for advising other government agencies and the private sector on ways to achieve the government's health objectives (Almalki, 2012).

The MoH provides health services at 3 levels (see Figure 1-1): primary, secondary and tertiary. The first level is primary health care centres. The second is general hospitals, and the third is specialist or tertiary hospitals. Primary Healthcare Centres (PHC) offer ordinary treatment for common illnesses and some emergency care. The PHC practitioners refer patients to the secondary level (General Hospital) in cases where more advanced care is required. Cases that need more complex levels of care are transferred to central or specialised hospitals (the tertiary level of health care) (Albejaidi, 2010; Almalki, 2012).

In addition to the MoH, there are two other healthcare providers: the private health sector and other governmental public healthcare bodies.

Private healthcare: private sector has grown rapidly over the past several years reaching a total of 145 hospitals (16648 beds) in 2012 in addition to 2218 dispensaries and clinics. Although private healthcare is the primary service for foreign workers, around 80% of all private healthcare services are being offered to Saudi citizens. This is due to high demand and difficulties to receive treatments in MoH facilities (Almalki, 2012).

Other government organisations: these organisations include referral hospitals (total 43 hospitals) such as King Faisal Specialist Hospital and Research Centre (KFSH&RC), Ministry of Defence and Aviation Medical Services, Ministry of Higher Education hospitals (teaching hospitals) and others see Figure 1-2. Most of these hospitals offer health treatments free of charge to employees and their dependants. Additionally, all of them provide health services to all residents during crises and emergencies.

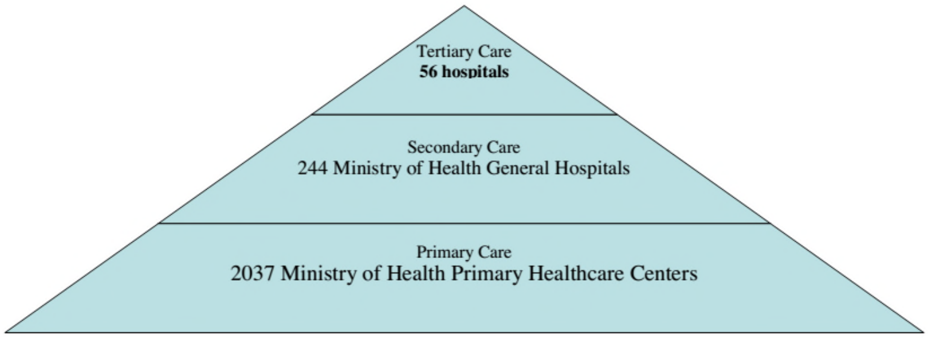


Figure 1-1 Healthcare Services Provided by the Ministry of Health (Albejaidi, 2010)

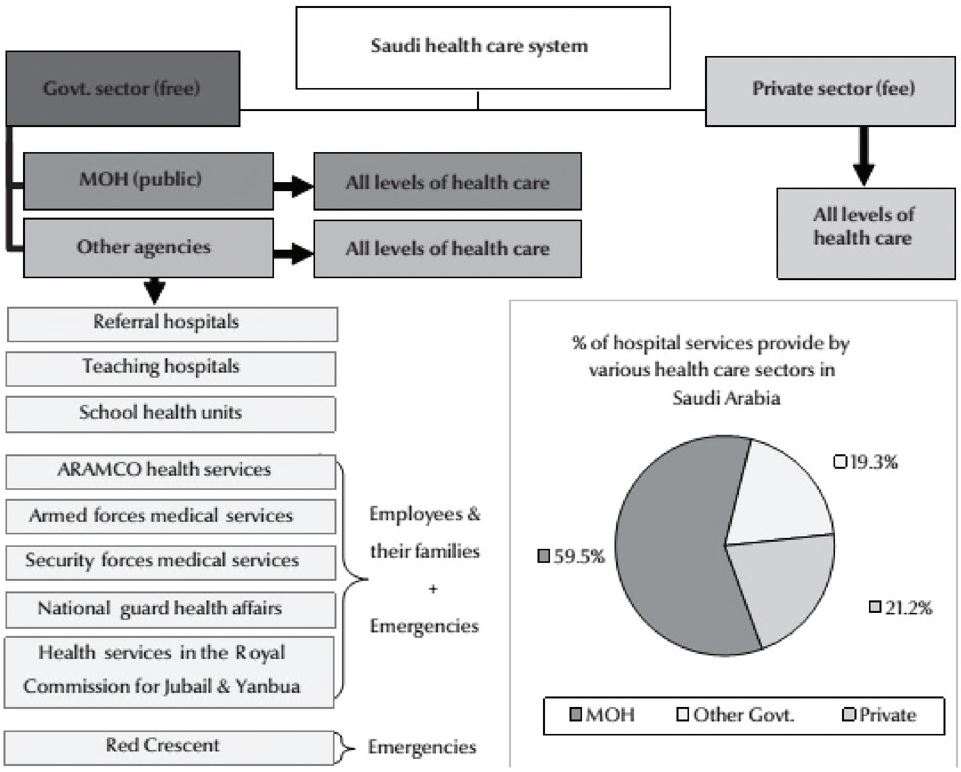


Figure 1-2 Current structure of the health care sectors in Saudi Arabia (Almalki, 2012)

1.4.2 HIT in Saudi Arabia: The Current Status

The awareness of IT benefit in Saudi Arabia is increasing. Both the government and private sectors are seeking to improve their transactions by the adoption of advanced IT systems. In the healthcare domain, the government aims to improve the quality and safety of healthcare services by the implementation of health information technology (Al-Harbi, 2011).

Globally, healthcare organisations use Health Information Systems (HIS) and technologies, systems such as Electronic Medical Records (EMR), Computer Based Patient Records (CBPR), Computerized Physician Order Entry (CPOE) or Pharmacy System (Hasanain, Vallmuur and Clark, 2014).

EMRs has already been used in a number of Saudi hospitals. Hasanain and Cooper (2014) reported that Electronic Medical Records (EMR) systems were first introduced in 1988 in Saudi. Yet the use of EMRs in MoH hospitals moves slowly. Al-Harbi (Al-Harbi, 2011) argued that most Saudi health organisations are totally dependent either on manual paper work or on very basic software tools to do their day to day tasks such as patient admissions. Altuwaijri (2008) stated that the Saudi Arabia e-health initiatives lag behind other sectors in the Kingdom, such as the banking and oil industries.

The MoH allocated 4 billion Saudi Riyals (around 1 billion US Dollar) during 2008-2011 to develop and implement e-health in Saudi Arabia. Additionally, in 2011 the MoH formed an Information and Communication Technology (ICT) team and developed a 10-year e-health strategic plan to improve the Saudi healthcare system and its services (Almalki, FitzGerald and Clark, 2011). To achieve this initiative, the Saudi Association for Health Informatics (SAHI) was established to promote scientific thinking in this field (Altuwaijri, 2010). This programme resulted in an increased number of people working in the field of health informatics, providing the help and requisite knowledge.

Despite the increased interest and investment by the MoH, HIS uptake has been very low and very few hospitals are in an advanced stage of implementation. The effort of adopting advanced information systems has not been supported by integration and coordination, resulting in the diversity in the systems used among healthcare providers (Almalki, 2012; Hasanain, Vallmuur and Clark, 2014). The varied health care systems lead to duplication of efforts and waste of resources, such as having to repeat x-rays or other tests in treating patients for the same health issues in different medical centres (Altuwaijri, 2010).

1.4.3 Nursing Workforce

The current nursing profession in Saudi Arabia is highly reliant on expatriate nurses from various countries. In a study by Al-Ahmadi (2002) about nurses in government hospitals in Riyadh, only 16% were Saudi, 71.3% were from South East Asia, 8.6% were from other Arab countries and 0.5% from Western nations. In the tertiary hospital Prince Sultan Military Medical City(PSMMC), 90% of the approximately 2800 qualified registered nurses are non-Saudi in origin, with different cultural backgrounds and specialties (Al-Kharji, 2014).

There is a serious nursing staff shortage in Saudi Arabia and there are many studies that discussed the factors related to such nursing shortage. Al-Ahmadi (2002) studied a number of Saudi hospitals in Riyadh and concluded that the nursing workforce in Saudi Arabia did not attract sufficient numbers of Saudi nurses due to reasons such as low salaries, shift schedules and social perception of nurses. Alonazi and Omar, (2013) were interested to explore the factors that influence nurses' turnover and retention. They found out that most of the nurses left their jobs due to family reasons (39.7%) followed by other reasons (37.3%). They also stated that 70% percent of all the paediatric nurses remained in their jobs, on average, for only 2.2 years. Additionally, health settings structure including hospital administration and leadership was found to be one of the most stressful factors for nurses. Although students view nursing as a secure job with a good income there is a negative image about its limited opportunities for independent work compared to other jobs. On the other hand, Al Omar (2004) claims that the shortage of nurses is a global problem as these are problems related with the image of nursing.

In 2008 there were 4778 Saudi nurses compared to 6718 non-Saudi nurses (Ministry of Health, 2015). Al Omar (2004) reported that the Saudisation programme gave a high priority to the recruitment and education of Saudi nationals in nursing programmes to satisfy the healthcare system's needs. Saudisation refers to 'A policy that promotes Saudi nationals to be educated and/or trained in all areas of employment to replace expatriate workers'. The target of the MoH Saudisation plan for the nursing workforce is to reach 50% Saudi nurses by 2025 with an annual nursing school output of 3,858 nurses. In implementing this plan, many strategies have been activated, such as increasing the number of nursing colleges in various geographical regions in Saudi Arabia, improving the quality of education and training, improving the salaries of national nurses and providing specialty training (Mufti, 2000). The proportion of Saudi nurses was 9 per cent in 1996, and in 2016 proportion of Saudi nurses had increased to around 38.3 per cent of all MoH nurses (Ministry of Health, 2015).

Cultural factors may slow down the Saudisation in nursing workforce. El Gilany and Al Wehady (2001) assessed the degree of satisfaction of female Saudi nurses with their working conditions. They founded that the majority of female 98.3% (229 out of 233) Saudi nurses preferred not to provide care to male patients.

1.4.4 Nursing Education

Nursing education in KSA was first introduced in 1958 through cooperation between the MoH and the World Health Organization (WHO), and it was a very limited programme for males only. Two health institutes were then established in 1961 and trained both women and men to become nurses' aides in hospitals (Miller-Rosser, K., Chapman, Y., Francis, 2006). In 1967, a special department of health education and training was created to develop health education including nursing department and schools. In 1992, a total of 46 health institutes were operating with 27 for females and 19 for males.

Although the majority of nurses in Saudi Arabia hold a Diploma in Nursing, the government realised that the needs of the nursing workforce exceeded the supply of Saudi nurses. The first Bachelor of Science in Nursing (BSN) programmes was established in 1976 at the King Saud University in Riyadh then King Abdulaziz University at Jeddah in 1977, after that at the King Faisal University in Dammam in 1987. Further, in 1987, a Master of Science in Nursing (MSN) programme was added at the King Saud University in Riyadh, limited to female nurses only (Miller-Rosser, K., Chapman, Y., Francis, 2006). All these programmes and courses were monitored under the supervision of the Ministry of Higher Education. In addition, a PhD programme was established through cooperation between King Abdulaziz University and some British universities in 1995 (Abu-Zinadah, 2006).

In addition to the MoH and MoHE, other government agencies have created nursing education programs in order to satisfy their own needs. Example are the Prince Sultan Cardiac Centre, the Medical Services of Army Forces, the National Guard Health Affairs and the King Faisal Specialist Hospital and the Research Centre (KFSH&RC). All these organisations have been providing nursing education at diploma level since 2002 (Almalki, FitzGerald and Clark, 2011).

In addition, KFSH&RC offered a local scholarship programme in collaboration with Monash University in Australia for Saudi female nurses who are unable to leave the country (Abu-Zinadah, 2006).

At PSMMC, the Continuing Professional Development Department provides support to new nursing staff, as well as current nurses. Nursing administration provides intensive orientation and training programmes for new nurses, including nursing competency exams. All new nurses receive induction programmes. Successful new staff will remain under supervision for three months before working unsupervised with patients. In order to ensure patient safety and the quality of nursing care, nursing competency exams, study days and other sessions of nursing development are mandatory annual requirements for all nurses in order to have their contracts renewed (PSMMC, 2009).

1.5 Research Aim

The aim of this research is to assist Saudi e-health initiatives through developing an adoption model that identifies the factors that influence the acceptance of Health Information Technology (HIT) among nurses at Saudi hospitals. This will provide guidance to hospital management to take appropriate decisions to achieve successful HIT adoption.

1.6 Research Objectives

The research of objective as following

1. To understand challenges and barriers which affect user adoption of IT.
2. To review models and frameworks used for nursing HIT adoption.
3. To model the nature of HIT issues with in depth cases in Saudi hospital.
4. To design and execute field research to collect data of nurses HIT adoption, through participation in real life HIT system implementation projects in Saudi hospitals.
5. To build a model of nurses adoption of HIT implementation.
6. To offer a number of recommendations for decision makers to achieve successful HIT adoption in the Saudi healthcare organisations.

1.7 Contribution to Knowledge

The research has a practical motivation to improve the success of HIT implementation. The scientific research creates a Nurses Adoption Model that extends the Technology Acceptance Model(TAM) with additional implementation factors. The research adds the human factors dimension to the established TOE (Technology, Organisation, Environment) Framework for technology adoption. The research put technology acceptance factors of both the individual end user and the organisation levels into one picture.

1.8 Thesis Structure

The research is divided into six stages: research definition, literature review, HIT Implementation Issues Framework (Initial Study), HIT implementation case studies, Nurses Acceptance Model and Discussion and Conclusion. Table 1-1 presents the stages in the research process, and the thesis chapters they are reported.

Table 1-1 Research plan in details and model development

Main study		Tasks	By	Output	Appendices
Stage 1	**Research Definition** **Chapter 1**	Research Background	Define research areas, research problem, objectives and scope	Research Context and Aim	-
Stage 2	**Literature review** **Chapter 1+2**	Review previous study	1. HIT implementation 2. Review the acceptance study related to nurses	HIT Implementation Issues Framework Extended TAM3	-
Stage 3	**HIT Implementation Issues Framework** (Initial Study) **Chapter 4**	PSMMC (Problems in Pharmacy Automation system)	1. Interview 2. Observation by using Business Process Model and Notation (BPMN) 3. Documentation	HIT Adoption Barriers (Published Paper)	Appendix A Interview questions, Doc, BPMN diagram
		Heraa Hospital (Delayed Dispensing Discharged Medication)	1. Failure modes and effects analysis (FMEA) 2. Ishikawa Root Cause Analysis	HIT Implementation Barriers	-
Stage 4	**HIT Implementation Case Studies** **Chapter 5**	Nurtal and Pharmatal System Implementation (Communication System) CardioPulmonary Resuscitation (CPR) System Implementation	1. Quasi-Experimental 2. Experimental	Nurtal and Pharmatal System Implementation (Published Paper) CPR System Implementation (Submitted Paper) Refined HIT Implementation Issues Framework Extended TAM3 Model for Nurses	Appendix B CPR system implementation figures and table Appendix C Nurtal system implementation figures and table

Stage 5	**Nurses Acceptance Model** **Chapter 6**	Testing the nurses' acceptance and intention behaviour towards the use of HIT systems	1. Questionnaires to 2 implementation projects 752 responses PLS-SEM 2. Cross-case analysis	Nurses Acceptance Model	Appendix D CPR system questionnaire and result Appendix E Nurtal system questionnaire and result Appendix F Pharmtal system questionnaire and result
Stage 6	**Discussion and Conclusion** **Chapter 7**			Future work	-

Stage One: (Research Definition): The research topic, research problem, aim, objectives and scope were defined.

Stage Two: (Literature Review): The literature review revealed that research about the critical factors affecting the nurses' adoption for health information technology (HIT) is fragmented. The summary on nursing and HIT in Saudi Arabia can be found in Chapter 1 and the technology acceptance context is deliberated in Chapter 2. At the end of the review, concepts of models and factors are explored. The output of this stage led to the research design.

Stage Three: (HIT Implementation Issues Framework): In Chapter 4, an initial study was conducted to review critical factors in the HIT adoption. Qualitative research strategy was used with multiple methods of data collection and analysis. The data collection and analysis were conducted in two hospitals (PSMMC and Heraa). These cases helped to understand the situation in real hospitals and identify the dimensions of HIT Implementation Issues Framework. These cases indicated that the best way to study is by combining existing knowledge and resources that could be found from multiple sources.

Stage Four: (HIT Implementation Case Studies): In this stage, the HIT Implementation Issues Framework was enriched by the experience gained in implementing two HIT systems in PSMMC. After that, the TAM3 model was extended to become the Nurses Acceptance Model. Description of the implementations are in Chapter 5.

Stage Five: (Nurses Acceptance Model): Three surveys were distributed to nurses in PSMMC to understand their intentions to accept and use two different types of HIT. Over 700 valid questionnaire responses were collected and analysed.

Stage Six: (Discussion and Conclusion): The final stage, the discussion addresses research findings, while the conclusion summarises the research contribution, future work and recommendation. This phase is reported in Chapter 7.

2 Literature Review: Theories and Models of Technology Acceptance

2.1 Introduction

This chapter provides a review of the theories and models relevant to the acceptance of HIT. End user acceptance of the new information technology is investigated by studying technology acceptance theories and models. The barriers and factors of new technology implementation are collected from the communities of diffusion of technology, including the Technology-Organisation-Environment(TOE) and studies reporting on HIT. Finally, the factors for HIT acceptance and barriers are presented.

2.2 Definition of IT Adoption

In many research, the adoption of IT and technological innovation are seen as equivalent (Thong, 1999). The adoption of a new technology can be related to a personal mental process, Spence (1999). Adoption, according to Rogers (2003), is the ability to establish complete use of the innovation and is an act or a single-point decision. On the other hand, the adoption of innovation by an organisation is described by Damanpour and Danial Wischnevsky (2006) as a process that leads to the introduction a new product, process, or practice. Damanpour (1991) stated that innovation adoption is the skill of the organisation to develop and implement the novel initiatives or activities.

Rogers (2003) defined the innovation adoption process as the decision of adoption and acquisition of new physical technology. He considered adoption as the acceptance decision of an innovation, whether the innovation is ultimately used by the adopter or not. This issue has been argued by many researchers as a partial representation of adoption and diffusion of innovation (Thong and Yap, 1995). Thong and Yap (1995) argued that the innovation adoption process is only meaningful if the decision to accept leads to the targeted adopter really using the innovation.

2.3 Theories of IT Adoption

International and regional healthcare organisations around the world, in addition to various scholars and researchers, have expended great effort towards developing HIT adoption models and frameworks for many types of healthcare systems (Yang *et al.*, 2013). Unfortunately, according to Altuwaijri, Bahanshal and Almehaid, (2011), literature concerning HIT adoption among nurses in Saudi Arabia is limited and the MoH interest has been low.

There are two main streams of theoretical models to explain the adoption and diffusion of technology. The first stream regards innovation in relation to behavioural intention towards technology. The focus in this stream is normally on individuals and the factors that influence their decision to adopt a specific technology. This include for instance: Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975); Theory of Planned Behaviour (TPB) (Ajzen, 1991); Technology Acceptance Model (TAM) (Davis, 1989); and Unified Theory of Acceptance and Use of Technology (UTAUT). These models aim to offer explanations of the elements for technology change acceptance. TPB predicts the common human behaviour towards technology change regarding attitudes, norms and beliefs association. Yet, the factors in these models are embedded in social consciousness, they are not capable to clarify the adoption process from an organisational perception (Gallivan, 2001).

The second stream explores the process inside an organisation for factors that influence the adoption and diffusion of technology in the whole organisation. For instance, “The Diffusion of Innovation” theory (DOI) (Rogers, 2003), presents a description of how an innovation spreads over a society. Comparatively, these models are more comprehensive: “...emphasise the social construction of the technology under investigation” (Choudrie *et al.*, 2014). The theory proposes that the predictors of organisational innovativeness (that enables new IT adoption) involve individual characteristics and characteristics of the organisation. These models identify other attributes which affect the level of diffusion; as well as relative advantage, complexity, compatibility, observability, and trailability.

2.3.1 Technology Acceptance Model (TAM & TAM2) and Limitations

Technology Acceptance Model (TAM) (Davis, 1989) is considered as one of the most common theories of the perception and factors which supports the acceptance of novel technologies. Fishbein and Ajzen (1975) introduced the

Theory of Reasoned Action (TRA) which is a model used to predict human behaviour towards technology. Fred Davis (1986) introduced the first improvement of TAM in his doctoral thesis as an extension of TRA in order to model the user acceptance of Information System (Davis, 1989). Since then, TAM could be counted as one of the widest used theoretical framework for information system usage (Koufaris, 2002). Davis (1989) stated that TAM is considered as the most effective model in research of factors of individual's information technology acceptance and to predict the users' intention. The main idea is to enhance IT usage through improving its acceptance. Acceptance can be improved only when the influential factors are discovered; by investigating the users perception of this technology (Davis, Bagozzi and Warshaw, 1989). Perceived usefulness and perceived ease of are the two major factors in TAM Figure 2-1 The Technology Acceptance Model, Version 1.

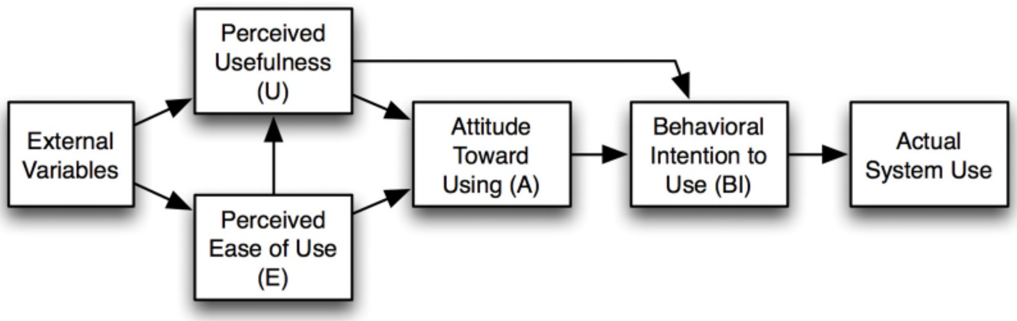


Figure 2-1 The Technology Acceptance Model, Version 1.

According to Shroff, Deneen and Ng (2011), manipulating these two factors provides more control over users' perception of the technology, and can support system developers in predicting users' behavioural intention and the real implementation of the system. In TAM, users' attitude to use a system is identified through the assessment of the positive or negative feeling of users in performing a specific behaviour. TRA is used by TAM as the theory to figure out the connection between the two factors and o the users' attitude, intention and real technology behaviour (Taylor and Todd, 1995). TAM is not similar to TRA in the aspect of subjective norms, TAM has not included subjective norms as a result of the weak findings of psychometric data generated (Davis, 1989).

Malhotra and Galletta (1999) states that ICT researchers have criticised the lack of subjective norms in this model. The inclusion of subjective norms in TRA is considered to cause theoretical and psychometric difficulties. They indicated that social impact does not appear to create a direct connection with behaviour intention even though it has an association with attitude. Taylor and Todd (1995) argue that the researchers believe that TAM does not investigate any obstacles that could hinder the individual adopting of a certain technology. Bogozzi (2007) confirms that TAM is too modest and ignores significant variables. Likewise, one of TAM's greatest popular criticisms is the lack of actionable help to the general practitioners (Lee, Kozar and Larsen, 2003). Yet, it is still accepted by others as an influential, valid and greatly reliable predictive model applicable in various conditions (Legris, Ingham and Collerette, 2003).

TAM limitations are explored in many studies by enriching the key predictor factors - perceived usefulness and perceived ease of use. Context specific factors were developed by some researchers for these two TAM constructs: Rauniar et al., (2014) for electronic communication (i.e., social media), Hong and Tam (2006) for multipurpose information appliances, and Cyr, Head and Ivanov, (2006) for M-commerce. Some researchers have developed common and context-independent factors that extent across a broad collection of systems (e.g., Venkatesh (2000); Venkatesh and Davis, (2000)).

TAM2 was introduced by Venkatesh and Davis (2000) through adding to the original edition two extra TAM determinants: social influences and cognitive instrumental processes. Social influences contain subjective norms and images. Cognitive instrumental consists of the following: job relevance, output quality, result demonstrability and perceived ease of use. The perceived ease of use in TAM2 is inherited from the original TAM and considered as a straight factor of perceived usefulness. All added factors are assumed to affect technology acceptance. Moreover, two moderating variables are included in this model: experience and voluntariness. Compared with TAM, the attitude variable were omitted in TAM2 (Holden and Karsh, 2010). Venkatesh and Davis (2000) have argued that the impact of subjective norms on behavioural intention can be disregarded.

2.3.2 Extension of the Technology Acceptance Model (TAM3)

Venkatesh and Bala (2008) further improved TAM to elaborate on "Perceived ease of use". They added extra factors: computer self-efficacy, perception of external control, computer anxiety and computer playfulness. Two more adjustment variables were added: perceived enjoyment and objective usability. TAM3 is based on a theoretical structure that consists of four categories that Venkatesh and Bala state as an integration of all TAM's prior researches (2008) These four categories are: individual differences, system characteristics, social influence and facilitating conditions (Howard et al., 2010). Moreover, subjective norms, job relevance, result demonstrability and image are the factors of the perceived usefulness. However, one of the criticisms of the model is that there are a lot of variables and many complex relationships between the variables.

Previous studies have considered TAM useful for the health sector. Holden and Karsh (2010) provide an inclusive analysis of literature in the healthcare area. This review used more than 20 experimental researches that used technology acceptance models (as TAM, TAM2, UTAUT) to evaluate end-users' acceptance and use of various health information technology applications, covering Computerised Physician Order Entry (CPOE) to Electronic Medical Records (EMRs). All the cases studied were published before 2008. They evaluated equally physicians and non-physicians, for instance nurses, pharmacists, and physician assistants. They reported that a high percentage of the variance in acceptance of health information systems could be predicted via TAM. On the other hand, they noticed that the TAM models must be contextualised to the particulars of the healthcare sites so that it offers more expressive results for policy makers and researchers concerned in the effectiveness of health information technology.

2.3.3 TOE Framework

The TOE framework established in Tornatzky and Fleischer (1990) has appeared as a concrete theoretical basis for understanding technology adoption (Ahmadi, Nilashi and Ibrahim, 2015). This framework concentrates on an organisation's process in the adoption and implementation of technological innovations. It conceptualises the technological, organisational, and environmental context effects of the new innovation implementation across different kinds of organisations(Tornatzky and Fleischer, 1990). It proposes that technological innovation adoption that occurs at the organisation level can be influenced by aspects that connect to their context. The internal and external technologies related to an organisation are described in the technological context. This consists of the organisation internal current practices and equipment, along with the set of existing external technology of the organisation. The internal factors of an organisation are represented via organisational context that influences the innovations adoption. Pudjianto and Hangjung (2009) stated that the TOE framework supports the understanding of tangible and non-tangible factors in any organisational context. These factors are: the organisational readiness in terms of strategic planning: strategies, culture, size, and administrative structure and upper management. Tornatzky and Fleischer (1990) refer to the external environmental context as the orgnisation's business conduction, the ability to access resource support, and the government and other organisation interactions. This consists of competitive, legal, and regulatory environment and the organisation marketing process.

The TOE framework has been used effectively by IS researchers to understand the contextual elements of new IS adoption (Baker, 2012). The adoption of e-business has been explained by the TOE model (Zhu, Kraemer and Xu, 2003, 2006; Zhu and Kraemer, 2005; Zhu *et al.*, 2006), and also E-commerce (Hong and Zhu, 2006), electronic data interchange (EDI) (Kuan and Chau, 2001; Seyal, Rahman and Mohammad, 2007), enterprise systems (Ramdani, Kawalek and Lorenzo, 2009), and IT usage (Zhang *et al.*, 2007). In terms of industries, the TOE model has been used to illustrate innovation adoption in manufacturing, retail, wholesale and financial services and health care (Zhu, Kraemer and Xu, 2006; Oliveira, Thomas and Espadanal, 2014). Geographically, the TOE model has been used in European (Oliveira, Thomas and Espadanal, 2014), American (Lee and Shim, 2007), and Asian contexts (Hsiao *et al.*, 2008), in both industrial and developing countries (Zhu and Kraemer, 2005; Hong and Zhu, 2006; Zhu, Kraemer and Xu, 2006; Alharbi, Atkins and Stanier, 2016; Ahmadi *et al.*, 2017). In the healthcare domain, TOE has been used to recognise the influential elements that related to adoption of medical records system (Marques *et al.*, 2011), hospital electronic tracking (Chang, Hwang, M.-C. Hung, *et al.*, 2007), and Telecare (Liu, 2011).

Researchers have developed essentially similar factors for the technological, organisational, and environmental contexts in the different empirical studies that use the TOE framework. In fact, researchers agreed with Tornatzky and Fleischer (1990) on the three TOE contexts. All these researchers have supposed that there is a unique set of elements or measures for each definite technology or context that is investigated. In Lee and Shim (2007) for example, the researchers discuss “perceived benefits” as a relevant factor in the technological context which influence the adoption of Radio-Frequency Identification (RFID). In the same way, these researchers discuss that “presence of champions” is a valid factor that ought to be investigated to understand the organisational context effects on the adoption of RFID. In their conclusion, “performance gap” and “market uncertainty” are considered as related factors in the process of understanding the environmental context that influence RFID adoption. Different kinds of innovations have different factors that affect their adoption. Also, various national/cultural contexts and different industries can lead to conflicting factors. As a result, each case can have different factors for the technological, organisational, and environmental contexts.

The TOE framework provides a good starting point when analysing and considering suitable factors for understanding the innovation-adoption decision, because it has many consistent empirical supports. The weaknesses of the TOE framework, according to Wang, Wang and Yang (2010), can be listed in two points: (1) the framework and the variables in any context may not be clearly indicated in the major constructs; (2) different studies located certain elements in more than one of the three contexts. Despite these weaknesses, the TOE framework is a good starting point for analysing and suggesting appropriate factors to consider the innovation-adoption decision, as it has many published empirical supports.

2.3.4 Human and Users Factors

Human factors are considered critical in the adoption process of any novel IT innovation. Such factors should be taken seriously on adopting HIT in health environment (Paré and Trudel, 2007). Yusof *et al.* (2008) introduce the HOT-fit model as an assessment framework for health information systems.

There are other human and user perspective issues that are relevant to nurses in healthcare organisations.

2.3.4.1 User Involvement

One of the often cited failure factor of IS developments is the lack of sufficient user involvement. Ives and Olson (1984) propose that throughout system development, if users are not involved, then there can be an inequality between the aims of system developers or implementers and users. System developers are mostly concerned with the technical aspects of IT systems, whilst users are mostly interested in the extent of impact of the new technology to their jobs. Most researchers who investigated the role of user involvement in IS progress (Choe, 1996; Lin and Shao, 2000; Malhotra and Galletta, 2004; Rondeau, Ragu-Nathan and Vonderembse, 2006; Bano and Zowghi, 2015) have discovered that user involvement has a positive influence on IS success.

Lack of adequate user involvement can lead to reduced system use (Choe, 1996), extend the development cycles of the project (LaPlante, 1991), and decrease the satisfaction and commitment levels of user (Avison and Fitzgerald, 2006). Avison and Fitzgerald (2006) suggest that IS needs to involve all the relevant users in the development of IS, mainly to involve them in the decision making practise. According to Hunton and Beeler (1997) users involvement in the development process creates better users' commitment to the IS, elevates the users' sense of ownership and as a result it enhance the possibility of successful implementation. Accordingly, this is a vital factor to successful IS (Fowler, 2009).

Yet, this factor is typically studied with the principle that all users are identical in terms of their system relationship.

2.3.4.2 User Training

User training is essential for successful individual IS adoption (Jeyaraj, Rottman and Lacity, 2006). Training programmes enable users to possess the required skills and knowledge. Radhakrishnan, David and Zaveri (2008) propose that health organisations should put more emphasis on training their users, and provide extra time to obtain the basic skills for in the use of the system. Sharma and Yetton (2003) argue that other variables may negate the positive influence of training on IS success. They argue that the higher degree of technical complexity and task interdependence, the less positive effect of training has on IS success.

Nour (2006) concluded in his study in Saudi Arabia that the benefits of EMR are not completely achieved at the study hospitals because the fundamental functions are either unknown or never used by physicians. This may suggest the ineffectiveness of the single day EMR training conducted at the study hospital. The requirement of a longer period of training and the application of other methods of training should be studied. Kirshner, Salomon and Chin (2004) and Edmonson *et al.*, (2005) investigate several teaching methods to train clinicians on EMR use including one-on-one training and online tutorial. Both approaches showed improved results than traditional lecturing method that is used at the study hospital. In the study to discover clinicians' perceptions of CPOE system in the intensive care unit of a leading health care organisation (Altuwaijri, Bahanshal and Almehaid, 2011), the researchers surveyed 43 clinicians to evaluate the perception regarding 32 factors collected from literature associated to the successful implementation of the CPOE system. The result of the ICU survey indicates that the most critical factors of success are: 1) The provision of training previous to system implementation, 2) Suitable clinical resources during implementation; and 3) offering sufficient time for ordering.

2.4 Factors that Influence Adoption of Health Information Technology

Literature is studied to harvest adoption factors relevant for this research. Literature databases were used to collect papers with technology and HIT adoption cases. These were supplemented with research theses. The sources were sorted into four categories for factors analysis. The broadest range of papers are those that report technology acceptance studies using any analytical framework in any countries of any Health Information Technology (HIT) systems. From these, papers that are related to CDSS and CPOE forms one group. The papers that report on studies with the Saudi context forms one group. And the final group are the papers that studied Saudi CDSS and CPOE implementations. The groups are mutually exclusive, so papers picked into the more narrow groups are not included in the analysis of the boarder groups.

To refresh the context, CPOE and CPSS as part of HIT is presented, then the factor analysis of the four groups are reported.

2.4.1 Heath Information Technology (HIT)

The following sections presents CPOE and CDSS as systems that could reduce medication errors, and the changes they bring to healthcare.

2.4.1.1 Computerised Physician Order Entry (CPOE)

The most common cause of Adverse Drug Events (ADEs) are prescribing errors, including wrong doses (Lesar *et al.*, 1990; Lesar, Briceland and Stein, 1997). CPOE is defined as "*the process of a medical professional entering medication orders or other physician instructions electronically instead of on paper charts*" (Prasad, 2017). CPOE represents an important step forward for healthcare organisations because it embodies a shift from traditional, paper-based care coordination activities to automation of the order entry processes. This shift can eliminate errors related to illegibility of handwriting or transcription of medication orders. Some of the common prescribing errors that can be reduced through CPOE are wrong drugs, frequency or dosage; incorrect route; and contraindicated drug use and interaction (Fontan *et al.*, 2003).

Using computers (CPOE) to assist in the prescribing of drugs is not a new idea (Shannon et al., 2002). Currently there is considerable effort to use CPOE to facilitate the improvements in delivering health care by increasing medication safety, improving the efficiency of providers and decreasing cost (Radley *et al.*, 2013). CPOE had resulted in a 55% reduction in medication errors (Bates *et* *al.*, 1998). With additional decision support features to the CPOE system, medication errors were reduced by 81% (Bates *et al.*, 1999). Another study conducted by Bobb et al.,(2004) at a 700-bed medical centre in Chicago reviewed a week's worth of medication orders error and determined that of the 1111 errors, 64.4% could have been prevented by a CPOE system.

In Saudi Arabia, CPOE has been used since the 2000’s. Some of these implementation had failed and many not fully implemented (Mominah, Yunus and Househ, 2013). Six studies were found in literature on Saudi CPOE implementations. Three studies reported that CPOE implementation could lead to positive results within organisations (Altuwaijri, Bahanshal and Almehaid, 2011; Saddik and Al-Fridan, 2012; Mominah, Yunus and Househ, 2013). Only one study reported mixed positive and negative results of CPOE (Al-Rowibah, Younis and Parkash, 2012), while two studies reported either no improvement in patient outcomes or a negative influence on clinical workflow (Omaish, Abidi and Abidi, 2012; Mominah, Yunus and Househ, 2013).

In the CPOE system, orders can be corroborated with patient information such as laboratory and prescription data and checked for potential errors or patient harm before the system transmits the order to the appropriate departments.

2.4.1.2 Clinical Decision Support System (CDSS) combined with CPOE

Incorporating CDSS into CPOE can further reduce medication errors. CDSS could help in checking for patient factors (age, weight, allergies, renal function) and drug factors (dose, frequency, route).

Fortescue et al. (2003) suggested possible strategies to prevent medication errors in paediatric patients and noted that CDSS combined with CPOE had great potential to reduce medication errors in paediatric inpatients. The risks for errors are greater during Paediatric CardioPulmonary Resuscitation (CPR) (Kozer *et al.*, 2004). There is some evidence that the use of a computerised calculator reduces prescribing error rates (Lehmann *et al.*, 2006), and may be significantly faster than manual paper based calculation (Shannon *et al.*, 2002). Shannon et al. (2002) assessed a web-based computer calculator for both adult and paediatric resuscitation medication dose calculation and demonstrated the potential of software assisted medication orders in the resuscitation setup.

Potts et al. (2004) evaluated errors that occurred during the medication ordering process in a Paediatric Critical Care Unit (PCCU) and reported CPOE significantly reduced the number of errors. In their study, the main benefit of CPOE was enhanced communication between health care professionals, thus decreasing the possible misinterpretation of medication orders.

Incorporating CDSS into hospital systems such as those for medication dosing may improve dosing, but it may not always result in clinical improvements and in some cases may result in increases in inappropriate therapy or duplicate medication orders (Wetterneck *et al.*, 2011; Faine *et al.*, 2015). In some cases (Milani, Oleck and Lavie, 2011), it can have an impact not only on patient safety but also on the length of stay, percentage of patients who reach low-density medical goals, and other metrics for patient outcome and hospital spending. The only study that evaluated CDSS combined with CPOE in Saudi Arabia was conducted by Almutairi et al (2012). Three hospitals in Riyadh were studied and found that there were many challenges, including the high cost to buy, customise and maintain both the CDSS and CPOE systems and the lack of qualified and experienced health information professionals who were familiar with international and national standards related to healthcare. Also, within each of the hospitals, some physicians preferred not to use CDSS-CPOE because they reported that it was difficult to use and time consuming.

There is data (see Table 2-1) on the impact of CDSS and CPOE on medication errors in paediatric patients and on errors occurring during paediatric resuscitation (Vardi *et al.*, 2007). Alsultan *et al.*, (2012) in their study entitled "Hospital pharmacy practice in Saudi Arabia: Prescribing and Transcribing in the Riyadh region" found that one-third (34.5%) (10 out of 29) of hospitals were equipped with CPOE systems with CDSSs. Qureshi *et al.*, (2015) criticised the previous and said “Saudis hospitals accept the need for CPOE and CDSS, but implementation across all health care delivery systems including the private sector has been minimal and slow, with only a few hospitals now having an CPOE and CDSSs.

Table 2-1 The reviewed studies on CPOE and CDSS base on calculator functions

Reference	Study Aim	Study design	Country and Setting	Main Outcome
Shannon *et al.* (2002)	21.4% greater accuracy than the paper-based method	Developed a program	UK Adult and paediatric resuscitation medication	Paper based model was 16. Computer model was 05:12 Result: 11.5 minutes quicker 26 forms
Reed and Fothergill (2007)	To developed a calculator based on Microsoft Excel document, and make it available on a computer in ED's resuscitation room at St John's Hospital	Developed a program	UK Paediatric emergency care	The calculator was developed and also can be used online. After the drug dose was calculators it is vital that is double checked by a second person before medication is administered.
Vardi *et al.* (2007)	Evaluate the impact of a CPOE/CDS on the frequency of errors in ordering and form completion time	Prospective cohort study before and after study	Israel multidisciplinary paediatric critical care unit of a children hospital	There was a 100% reduction in errors and time required was significantly reduced Errors: Before: 3 After :0 Time: Before: 14 min 42s After: 2 min 14s 80 forms
Hamad *et al.* (2015)	Evaluate impact of online dose calculators on initial dose accuracy	Pre/ post intervention	UK	Calculators significantly improved initial antibiotic dosing

2.4.2 Analysis of HIT Acceptance Publications

The TOE framework has been used by many researchers for a wide range of technology innovations. Some researchers suggested that the TOE framework missed variables in the individual context (Low, Chen and Wu, 2011). Marques *et al*. (2011) reports the barriers in European hospitals Medical Records System (MRS) implementations. The author emphasises that factors involved in the human context should be considered when adopting and implementing any technology innovation in healthcare organisations.

In this research, the H-TOE framework is created as a more robust multi aspects framework, using TOE as a starting concept and the addition of the Human-Organisation-Technology fit (HOT-fit) model (Yusof *et al.*, 2008) Figure 2-2.

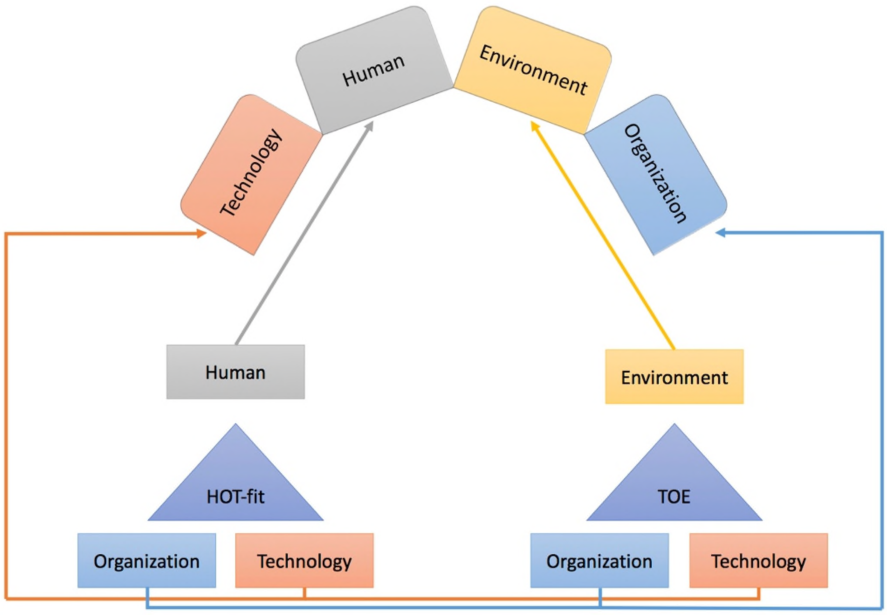


Figure 2-2 H-TOE combining TOE and HOT-fit

Prior studies on HIT adoption by nurses and other healthcare professional were analysed using H-TOE framework Table 2-2. Each paper was listed based on the types of innovation, the study theories, country and the case setting. Acceptance factors reported were categorised into the Technology, Organisation and Environment columns according to the H-TOE context. Additional contexts like Human are annotated in the context columns.

The table is divided into three sections. The first group of 10 studies used only the TOE framework as their study theory. The second group of 4 combined TOE with HOT-fit as their study theory. The third group of 7 papers combined TOE with some other acceptance models. Most of the studies focused on the factors in the organisation level (technology, organisation and environment). Only a few considered the human factors. Some studies expanded the TOE framework to have “project planning context” and “business context”.

In

Table 2-3 the factors were ranked based on the number of papers that reported them. The most cited factor is “relative advantage” in the technology context. “Top management support” (10 times) is the most cited factor in the organisation context, which is an obvious barrier worldwide. The most cited factor for the human context is “CIO Innovativeness” which gained 3 scores.

Table 2-2 Summary of prior studies factors affecting adoption based on H-TOE framework among nurses and other healthcare professional

Author(s)	Types of innovation	Theories	Countries	Setting and Methods	Technology	Organisation	Environment
				TOE Framework			
Chang *et al.* (2006)	Picture archiving and communication system (PACS)	TOE	Taiwan	35 Questionnaires 2 two interviewees	• Cost of PACS • Compatibility • Benefits of PACS (+)	• Business Competition • Governmental Policies (+)	• Centralisation • Formalisation • High-Level Manager Support (+)
Hsiao *et al.* (2008)	Mobile Nursing Information Systems (MNIS)	TOE	Taiwan	84 Nursing Directors Multivariate regression analysis	• Mobile Devices Suitability • Mobile Communication Suitability • The extent of integration with HIS • Cost Benefit	• Project Team's Capability • Top Management Support • User Involvement and Cooperation • Championship • Internal Needs	• Business Competition • Government Policy Support • External Supplier's Support
Hung *et al.* (2010)	Customer relationship management systems (CRMS)	TOE	Taiwan	95 Questionnaires Multivariate regression analysis	• Relative advantage • Complexity	• Size of organisation • IS capabilities of staff • Innovation of senior executives • Knowledge management capabilities	-
Liu (2011)	Telecare	TOE	Taiwan	70 Questionnaires Multivariate Regression Analysis	• Compatibility • Relative Advantage • Supplier Support	• Top management support • Internal need • Technological Knowledge **Project planning (Context)**	• Government Support • Business competition pressure

						Team Skills, Resources, and user participation	
Chang, Hwang, M.-C. Hung, *et al.* (2007)	Electronic Signature (e-signature)	TOE	Taiwan	Multivariate Regression Analysis	• Security protection • System complexity	• User involvement • Internal need • Adequate resources • Hospital size	• Vendor support • Government policy
Li et al. (2005)	Mobile Nursing	TOE	Taiwan	216 Responses Multivariate Regression Analysis	• The characteristics of mobile devices • The characteristics of mobile communication • The extent of integration with HIS	• Project team's capability • Top management support • The extent of user acceptance and cooperation • Championship • Internal needs • Cost benefit	• Business competition • Government policy • External supplier's coordination • The capability of external suppliers
Vest (2010)	Health Information Exchange (HIE)	TOE	USA	4830 hospitals	• Technological readiness • Certified EHR • Point-to-point connections technology	• Control • Vertical Integration • Horizontal Integration • Information Needs	• Competition • Uncompensated care burden
Ismail, Abdullah and Shamsuddin (2015)	Hospital Information System (HIS)	TOE	Malaysia	All Staff, 229 Respondents	• Perceived Usefulness • Perceived ease of use • System Quality	• Managerial Control • Vendor **Human (Context)** • Information Quality • User Satisfaction • Skill and Experience	• Environmental • Training
Lee and Shim (2007)	RFID	TOE	USA	126 Senior executives Theory of technology-push and need-pull	• Perceived benefits • Vendor pressure	• Presence of champions	• Performance gap • Market uncertainty

Sulaiman and Magaireah (2014)	Cloud-based e-health record EHR system	TOE	Jordan	5 interviewees IT healthcare experts and cloud computing provider	• Privacy • Security • Reliability	• Top Management Support • Technology Readiness	• Government Policy • Legal Environment • Competition
TOE combined with HOT-fit Frameworks							
Marques *et al.* (2011)	Medical Records System (MRS)	TOE+ HOT-fit	European	Computer-aided telephone interview (CATI) technology	• Technology Readiness	• Hospital Type • Hospital Size • Hospital Ownership **Human (Context)** • Education Levels • Teaching/Research	• Country Wealth • Competitive Pressure
Lian, Yen and Wang (2014)	Health cloud computing	TOE+ HOT-fit	Taiwan	Multivariate Regression Analysis	• Data security • Complexity • Compatibility • Costs	• Relative advantage • Top manager's support • Adequate resource • Benefits **Human (Context)** • CIO innovativeness • Perceived technical competence	• Government policy • Perceived industry pressure
Ahmadi *et al.* (2017)	Hospital Information System (HIS)	TOE+ HOT-fit	Malaysia	131 questionnaires Multivariate Regression Analysis	• Relative advantage • Compatibility • Complexity • Security concern	• IS infrastructure • Top management support • Financial resources • Hospital size **Human (Context)** • Perceived technical competence of IS staff • Employees' IS knowledge	• Mimetic pressure-competitors • Coercive pressure-government • Vendor support

Ahmadi *et al.* (2015)	Hospital Information System (HIS)	TOE+ HOT-fit	Malaysia	Multivariate Regression Analysis	• Relative advantage • Compatibility • Complexity • Security concern	• IS infrastructure • Presence of Champions • Top management support	• Vendor support
TOE combined with Acceptance Models							
Faber, van Geenhuizen and de Reuver, (2017)	eHealth	TOE +DOI	Netherlan ds	Multivariate Regression Analysis 30 Questionnaires CIO and top level ICT manager	-	• Size of hospital (+) • Top management support (+) • Organisational readiness (+) • Centralisation in decision-making (-,+) • Absorptive capacity (+)	-
Yang *et al.* (2013)	Vital signs monitoring system	Framewo rk TOE + DOI	Singapore	25 interviews Cross-case analysis of pilot trials conducted in two large public hospitals	• Relative advantage • Complexity • Compatibility	• Internal needs • Resource availability • Technological knowledge • Project team capability • Top management support • Champion Type	• Government involvement • Vendor partnership
Yun (2013)	Knowledge Management System	TOE + TAM	Korea	245 Survey Nurses Multivariate Regression Analysis	• Information competency (IC) (+) • Hospital Information System (HIS) (+)	• Clan culture (+) • Adhocracy culture (+) • Hierarchy culture (+) • Market culture (-)	-
Al-Hadban, Hashim and Yusof (2016)	Healthcare Information Systems	TOE + UTAUT	Iraq	551 Questionnaires Multivariate Regression Analysis Medical Staff Administrative Staff	• Performance Expectancy (PE) • Effort Expectancy (EE)	• Top Management Commitment (TMC) • Top Management Innovativeness (TMV)	• Vendor Support (VS) • Government Support (GVS)

					• Social Influence (SI) • Facilitating Conditions (FC)		• Work Overload (WOL)
Alharbi, Atkins and Stanier (2016)	Cloud Computing decision making processes	TOE, Strategic Triangle and HOT-fit.	Saudi Arabia	Framework	• Relative advantage • Technological readiness • Compatibility • Complexity • Security	• Top management Support • Change Resistance • Firm Size **Business (Context)** • Financial Analysis • New Service and Applications • New Business Model	• Government Legislations • Trading Partners Peressure • External Expertise **Human** • CIO Innovativeness • Internal Expertise • Prior Technology Experience
Alaboudi, ATKINS and Sharp (2015)	Telemedicine	TOE + IS Strategy + UTAUT2	Saudi Arabia	Framework	• Capability (HR/ ICT/IS) • Interoperability • Privacy & Security • Reliability • Quality (ICT facilities/IS) • Validity • Availability	• Compatibility • Change management • Risk Management • Sustainability • Affordability **Business (Context)** • Financial analysis	• The national level challenges • The STN standards • Culture • Politics • External organisation infrastructure **Human (Context)** • Acceptability • Confidence • Usability

Nilashi *et al.* (2016)	Fuzzy Analytic Network Process (ANP)	TOE + HOT-fit + DOI	Malaysia	Multivariate Regression Analysis	• Relative advantage • Compatibility • Complexity • Security concern	• Presence of champions • Infrastructure • Top management support • Hospital size • Financial resources **Human (Context)** • Perceived technical competence of IS staff • Employees' IS knowledge • Clinical IT experts • CIO innovativeness	• Mimetic pressure • Coercive pressure • Intensity of competition • Vendor support

Table 2-3 Number of papers citing each factor based H-TOE framework

Technology (18)	No of studies	Organisation (26)	No of studies
Relative Advantage	7	Top Management Support	10
Compatibility	6	Hospital Size	6
Complexity	5	IS capabilities of Staff	4
Cost Benefit	2	Internal Needs	4
Security Concern	5	Resource Availability (Adequate)	3
Technology Readiness	4	Technological Knowledge	2
Benefits of PACS (Perceived Benefits)	2	Project Team Capability (Skills + Experience)	4
Old Infrastructure	3	Presence of Champions	4
Point-to-point Connections Technology	1	User Involvement and Cooperation	3
System Quality	1	Control	2
Mobile Devices Suitability	1	Innovation of Senior Executives	2
Mobile Communication Suitability	1	Financial Resources	2
The Extent of Integration with HIS	1	Teaching/Research/Training	2

Certified EHR	1	Knowledge Management Capabilities	1
Information Competency (IC)	1	Performance Gap	1
Hospital Information System (HIS)	1	Clinical IT Experts	1
Reliability	1	Hospital Type	1
Privacy	1	Hospital Ownership	1
		Education Levels	1
		Adhocracy Culture	1
		Horizontal Integration	1
		Vertical Integration	1
		Hierarchy Culture	1
		Market Culture	1
		Clan Culture	1
		Benefits	1
Environment (15)	**No of studies**	**Human (6)**	**No of studies**
Vendor Partnership (Support) (Pressure)	9	CIO innovativeness	3
Government Policy (Support)	6	Perceived Technical Competence of IS Staff	3
Intensity of competition (Business)	4	Perceived Usefulness (Performance Expectancy)	2
Mimetic Pressure (competitors)	3	Perceived Ease of Use (Effort Expectancy (EE))	2
Coercive Pressure (government)	2	Subject Norm	1
Government Involvement	2	Facilitating Conditions	1
Legal Environmental	2		
Centralisation (decision-making)	1		
Uncompensated Care Burden	1		
High-Level Manager Support	1		
Market Uncertainty	1		
External Supplier's Support	1		
Perceived Industry Pressure	1		
Country Wealth	1		
Work Overload	1		

2.4.3 Analysis of CDSS Acceptance Publications

12 studies were found that reported on CDSS implementations. 5 of them specifically used the TAM model to study acceptance. Each paper was listed based on the types of innovation, the study theories, country and the case setting (Table 2-4). As the focus of some studies were not specifically on factors of acceptance, the column of Key Findings was used to summarise learning related to acceptance. The factors were then interpreted, and ranked according to the H-TOE constructs (Table 2-5).

Buenestado *et al.*, (2013) conducted a study to find out the early attitude of physicians to the use of Clinical Decision Support Systems (CDSS) based on Computerised Clinical Guidelines and Protocols (CCGP). This was to determine the doctors' use of the system and if there are any positive effects on the doctors intention of future adoption on the long term. Based on TAM, a (pre-post) questionnaire was designed and it was administered to 8 participants who were paediatricians and had used a CDSS (e-GuidesMed) for three months. The result indicated that the physicians' initial disposition to the new system is positive. In addition, compatibility and habit variables of the participants reflect potential difficulty in e-GuidesMed integration in daily work. The highest correlation with the intention of use is the facilitators variable.

A similar study was done to investigate the physician's perceived professional autonomy, involvement in the decision of CDSS implementation and the acceptance of CDSS Sambasivan *et al.*, (2012). In Kuala Lumpur, Malaysia, a survey was administered in seven public and five private hospitals from all specialities. 450 physicians participated randomly in the questionnaire. The result of the hypotheses were tested by using Structural Equation Modelling (SEM) and it indicated that the threat of professional autonomy is perceived by physicians as a negative factor to the intention to use CDSS. In contrast, involving physicians in the planning, designing and implementation increases their willingness to use CDSS.

Table 2-4 The reviewed studies on CPOE combined with CDSS among nurses and other healthcare professional

Authors, Year	Country	Technology/ Platform	Subjects	Sample/ used	Method	Key Findings
Kroth *et al.*, (2006)	US	CDSS	Nurses/ patient's	44339 temperature control group 45823 temperatures intervention group	- Experimental Study	Result showed a 51% relative reduction in the number of erroneous low temperatures stored by the intervention versus the control group.
de Vries *et al* (2013)	Netherlands	CDSS support guideline adherence in heart failure	Nurses	220 questionnaires	Responsibility, Trust, Barrier, Threat, Knowledge management	74%. Barriers were found for cardiologists and HF nurses in all the constructs. Sixty-five percent did not want to be dependent on a CDSS. Nevertheless thirty-six percent of HF nurses and 50% of cardiologists stated that a CDSS can optimize HF medication.
Koskela et al (2016)	Finland	CDSS	Physicians and nurses	5 Groups Semi-structured interview questions	-	The most important barrier to benefitting from CDSS was the lack of structured and coded diagnosis documentation and outdated medication information in the electronic health records.
Nachtigall *et al.*, (2014)	Germany	Implementation of a CDSS	Patients	1316 patients	-	Adherence to guidelines increased from 61% prior to implementation to 92% in post1, decreased in post2 to 76% and remained significantly higher compared with baseline in post3, with 71% (p=0.178). Additionally, antibiotic-free days increased over study periods. At all time periods, mortality for patients with low guideline adherence was higher with 12.3% versus 8% (p=0.014) and an adjusted OR of 1.56 (95% CI 1.05 to 2.31).
Campion (2011)	USA	Surgical and trauma ICUs in academic medical centre	Nurses	49 hours of observation and 49 instances of RNs using	Direct observation and unstructured	The authors noted significant barriers to use. These include: lack of reminders, inaccurate user interface design. Similarly the authors noted facilitators to successful use. These include:

				intensive insulin therapy; 16 patients observed; 25 nurses observed; 27 nurses interviewed	interviews of RNs	nurse trust in the CDSS with clinical judgment. Limitations: Small sample, unstructured interviews
Cho, Staggers and Park (2010)	Seoul Korea	Two teaching hospitals	32 RNs, only 18 completed study, 56% participation rate 2 written scenarios	Two written scenarios	Repeated measures factorial design (split- plot design) and feedback from nurses	User preferences for display of information in CDSS differed significantly between novice and expert nurses. The novice nurses wanted to see all possible problems for patients, whereas expert nurses only wanted the top five problems. The nurses stated that the CDSS was well organized and facilitated patient problem identification. The nurses also felt that automatics suggestions and data driven approaches to assessments were desirable features of the system. The nurses felt that the CDSS was tedious and difficult to input data and the display for data input was too complicated.
Choi *et al.*, (2011)	Korea	Six hospitals in a single university medical system	37 Nurses	Qualitative focus-groups	Discussion guidelines developed for focus groups	The nurses consistently stated that CDSSs can contribute to improving nursing outcomes by standardizing nursing care. The nurses wanted a system to remind them of scheduled care, assesses deleterious changes in patient condition, and acuity level. Nurse wanted a system that allowed customized guidelines for patients. Limitations: Small sample, conducted in foreign country with different health system than USA
CPOE and CDSS combined with Technology Acceptance Model						
Sedlmayr et al (2013)	Germany	CDSS	Physicians	6 physicians were observed 12 questionnaire	TAM 2, Compatibility and Resistance to Change	During field observations, we did not observe direct use of any of the implemented interventions for medication safety (paper-based and electronic). Questionnaire results indicated

						that the electronic medication safety check was the most frequently used intervention, followed by checklist and posters. However, despite their positive attitude, physicians most often stated that they use the interventions in only up to ten percent for subjectively “critical” orders. Main reasons behind the low usage were deficits in ease-of-use and fit to the workflow. The intention to use the interventions was rather high after overcoming these barriers.
Esmaeilzadeh, Sambasivan and Nezakati (2014)	Malaysia	CDSS (factors affecting)	Physicians	12 hospitals 300 questionnaires	TAM and extended to Perceived Threat and Perceived Interactivity	The results reflect the importance of perceived threat to professional autonomy, perceived interactivity with clinical IT, perceived usefulness and perceived ease of use in determining physicians’ intention to use CDSS.
Sambasivan *et al.,*(2012)	Malaysia	CDSS	Physicians	450/335, 309 usable	UTAUT variables except FC & SN	Perceived threat lowers the intention to use, involvement increases intention to use, and the belief also increases the intention to use.
Chang, Hwang, W.-F. Hung, et al., (2007)	Taiwan	CDSS (Prototype)	Physicians	115 physicians 3 hospitals (a medical center, a district teaching, and a local hospital)	UTAUT	Both performance expectancy and effort expectancy have significant impact on physicians’ intention to use the CDSS, and further influence their actual utilization behavior.
Buenestado *et al.,* 2013 (Buenestado *et al.*, 2013)	Spain	CDSS	Physicians	8	TAM Variables	The physicians attitude towards CCGP-based CDSS is good, PU, ATT, OEU, COM, FAC are highly correlated with IU, and SN and HAB are not correlated.

Table 2-5 Number of papers citing each factor for CPOE combined with and CDSS based on H-TOE framework

Technology		References
Complexity	11	(Leslie *et al.*, 2006; Bossen, 2007; Légaré *et al.*, 2008; Trivedi *et al.*, 2009; Hains *et al.*, 2009; Harrison *et al.*, 2009; Trafton *et al.*, 2010; Ahmadian *et al.*, 2011; Peek *et al.*, 2011; Almutairi *et al.*, 2012; O'Sullivan *et al.*, 2014)
Aligned with workflow	6	(Lai *et al.*, 2006; Courtney, Alexander and Demiris, 2008; Trivedi *et al.*, 2009; Randell and Dowding, 2010; Campion *et al.*, 2011; Choi *et al.*, 2011)
Interoperability	5	(Lai *et al.*, 2006; Trivedi *et al.*, 2009; Hor *et al.*, 2010; Trafton *et al.*, 2010; Ahmadian *et al.*, 2011)
Less authenticity/ Reliability of information	4	(Lai *et al.*, 2006; Varonen, Kortteisto and Kaila, 2008; Hor *et al.*, 2010; Ahmadian *et al.*, 2011)
Less user friendly/ Interface usability/ Poor system or technical design	4	(Wilson and Opolski, 2009; Hor *et al.*, 2010; Campion *et al.*, 2011; Robertson *et al.*, 2011)
Too many unwanted alerts	2	(Robertson *et al.*, 2011; Mominah, Yunus and Househ, 2013)
Knowledge-base	2	(Campion *et al.*, 2011; Mozaffar *et al.*, 2016)
Safety issues	1	(Mozaffar *et al.*, 2016)
Flexibility	1	(Choi *et al.*, 2011)
Lack of infrastructure	1	(Mozaffar *et al.*, 2016)
Compatibility	1	(Trivedi *et al.*, 2009)
Unrealistic or unclear business cases / Vision	1	(Mozaffar *et al.*, 2016)
Potential for error in operating medical devices	1	(Campion *et al.*, 2011)
Lack of detailed planning	1	(Mozaffar *et al.*, 2016)
Organisation		**References**
Economic constraints/ finance and resources/High cost	5	(Subramanian *et al.*, 2007; Egger Halbeis *et al.*, 2008; Kazemi *et al.*, 2009; Ahmadian *et al.*, 2011; Peek *et al.*, 2011)
Reluctance to use system in front of patients	5	(Leslie *et al.*, 2006; Toth-Pal *et al.*, 2008; Varonen, Kortteisto and Kaila, 2008; Harrison *et al.*, 2009; Wilson and Opolski, 2009)
Poor customer support	3	(Egger Halbeis *et al.*, 2008; Varonen, Kortteisto and Kaila, 2008; Trafton *et al.*, 2010)
Social barriers/lack of social acceptance	2	(Lai *et al.*, 2006; Kazemi *et al.*, 2009; Peek *et al.*, 2011)
Poor computer skills	2	(Leslie *et al.*, 2006; Toth-Pal *et al.*, 2008; Kazemi *et al.*, 2009)
Lack of flexibility (Work flexibility)	2	(Leslie *et al.*, 2006; Hor *et al.*, 2010)

Loss of productivity	1	(Subramanian *et al.*, 2007)
Leadership	1	(Randell and Dowding, 2010)
Access	1	(Marshall, West and Aitken, 2011)
Champions	1	(Randell and Dowding, 2010)
Limited supplier capacity	1	(Mozaffar *et al.*, 2016)
Resources	1	(Randell and Dowding, 2010)
Environment		**References**
Obscure workflow issues	3	(Lai *et al.*, 2006; Varonen, Kortteisto and Kaila, 2008; Robertson *et al.*, 2011)
Difficulty of competing clinical demands	3	(Varonen, Kortteisto and Kaila, 2008; Trafton *et al.*, 2010; Ahmadian *et al.*, 2011)
Lack of agreements with the system	1	(Cobos, et al., 2005)
Age	1	(Alquraini *et al.*, 2007)
Cultural concerns	1	(Kazemi *et al.*, 2009)
Gender	1	(Alquraini *et al.*, 2007)
Human		**References**
Lack of training/ Level of Education	8	(Egger Halbeis *et al.*, 2008; Toth-Pal *et al.*, 2008; Kazemi *et al.*, 2009; Hor *et al.*, 2010; Randell and Dowding, 2010; Ahmadian *et al.*, 2011; Almutairi *et al.*, 2012; Mozaffar *et al.*, 2016)
Lack of time	7	(Subramanian *et al.*, 2007; Toth-Pal *et al.*, 2008; Harrison *et al.*, 2009; Trafton *et al.*, 2010; Ahmadian *et al.*, 2011; Robertson *et al.*, 2011; Almutairi *et al.*, 2012)
Experience with system	7	(Cobos *et al.*, 2005; Alquraini *et al.*, 2007; Cho, Staggers and Park, 2010; Ahmadian *et al.*, 2011; Choi *et al.*, 2011; Peek *et al.*, 2011; O'Sullivan *et al.*, 2014)
Lack of knowledge of system	5	(Lai *et al.*, 2006; Toth-Pal *et al.*, 2008; Varonen, Kortteisto and Kaila, 2008; Robertson *et al.*, 2011; O'Sullivan *et al.*, 2014)
Physician/user attitude towards the system	4	(Varonen, Kortteisto and Kaila, 2008; Ahmadian *et al.*, 2011; Caldon *et al.*, 2011; Peek *et al.*, 2011)
Self-Efficacy	3	(de Vries *et al.*, 2013; Hsiao, Wu and Chen, 2013; Sedlmayr *et al.*, 2013)
Challenge to autonomy	2	(Hains *et al.*, 2009; Trivedi *et al.*, 2009)
Lack of familiarity	2	(Trivedi *et al.*, 2009; Peek *et al.*, 2011)
Lack of motivation/incentives	1	(Hor *et al.*, 2010)
Lack of awareness	1	(Peek *et al.*, 2011)
Result Demonstrability	1	(Sedlmayr *et al.*, 2013)

2.4.4 Analysis of Saudi HIT Acceptance Publications

29 papers have been found that reported health information technology (HIT) implementations in Saudi hospitals. The majority of the papers were not studies on acceptances and the analytical in the previous two sections cannot be used. Table 2-6 identified 34 barriers classified into H-TOE framework.

Most of the works focus on the organisational level on Electronic Medical Records (EMRs) implementations. A number of studies explored the issues from the nurses' prospective. Saudi specific situations are about the lack of future plans and strategies in MoH institutions, along with the system's internal interoperability problems, and low interoperability with other health organisations (Aldosari, 2014).

In the technology context, the most cited factors (7 times) are complexity, countless maintenance problems, security and confidentiality. Complexity is the highest scored technology adoption factor affecting the HIT worldwide as well as in Saudi hospitals. In the organisations context, many works discuss the lack of training (10 times) in Saudi hospitals and recommended further studies to improve the training efficiency.

Table 2-6 Number of papers citing each factor based H-TOE framework in Saudi hospitals

Technology	No	Reference
Complexity	7	(Davidson and Heslinga, 2006; Halamka *et al.*, 2006; Kumar and Aldrich, 2010; Alkraiji, Jackson and Murray, 2013; Hasanain and Cooper, 2014)
System requard a lot of maintenance problems	7	(Khudair, 2008; Al-Harbi, 2011; Mogli, 2012; Zaher, 2012; Khalifa, 2013; Hasanain and Cooper, 2014; El Mahalli, 2015)
Security and confidentiality concerns	7	(Al-Shorbaji, 2008; Altuwaijri, 2008; Khudair, 2008; Mogli, 2012; Khalifa, 2013; Hasanain and Cooper, 2014; El Mahalli, 2015)
Lack of a standardised	6	(Al-Shorbaji, 2008; Altuwaijri, 2008; Alkraiji, Jackson and Murray, 2013; Khalifa, 2013; Hasanain and Cooper, 2014; Hasanain, Vallmuur and Clark, 2014)
Old Infrastructure	6	(Halamka *et al.*, 2006; Khoumbati, Themistocleous and Irani, 2006; DesRoches *et al.*, 2008; Kumar and Aldrich, 2010; Alkraiji, Jackson and Murray, 2013; Hasanain and Cooper, 2014)
Mapping Issues	6	(Davidson and Heslinga, 2006; Halamka *et al.*, 2006; Bah *et al.*, 2011; Iroju, Soriyan and Gambo, 2012; Alkraiji, Jackson and Murray, 2013)
Lack of Business Process (Workflow)	5	(Davidson and Heslinga, 2006; Halamka *et al.*, 2006; Jha *et al.*, 2009; Hellman, 2010; Jamoom *et al.*, 2014)
Unfriendly interface design (Design and implementation/ poor IT design and planning	2	(Khudair, 2008; Khalifa, 2013)
Shortage of computer terminals	1	(El-Mahalli, El-Khafif and Al-Qahtani, 2012)
Slow networks	1	(Khalifa, 2013)
Organisation	**No**	**Reference**
Resistance to change	10	(Al-Shorbaji, 2008; Altuwaijri, 2008; Alsultan *et al.*, 2012; Mogli, 2012; Wahabi and Alziedan, 2012; Zaher, 2012; Alkraiji, Jackson and Murray, 2013; Hasanain and Cooper, 2014; Hasanain, Vallmuur and Clark, 2014)
Lack of training (Lack of time allowed to learn and train about using HIS)	10	(Khoumbati, Themistocleous and Irani, 2006; Mourshed, Hediger and Lambert, 2006; Al-Shorbaji, 2008; Jha *et al.*, 2009; Bah *et al.*, 2011; Alsultan *et al.*, 2012; Mogli, 2012; Zaher, 2012; Khalifa, 2013; Jamoom *et al.*, 2014)
Lack of financial support (7)	7	(Al-Shorbaji, 2008; Khudair, 2008; El-Mahalli, El-Khafif and Al-Qahtani, 2012; Wahabi and Alziedan, 2012; Zaher, 2012; Alkraiji, Jackson and Murray, 2013; Khalifa, 2013)
Lack of knowledge	7	(Al-Shorbaji, 2008; Altuwaijri, 2008; El-Mahalli, El-Khafif and Al-Qahtani, 2012; Wahabi and Alziedan, 2012; Khalifa, 2013; Hasanain and Cooper, 2014; El Mahalli, 2015)
Shortage of professionals	7	(Al-Shorbaji, 2008; Wahabi and Alziedan, 2012; Alkraiji, Jackson and Murray, 2013; Alsultan *et al.*, 2013; Khalifa, 2013; Hasanain, Vallmuur and Clark, 2014)

Costs	7	(Davidson and Heslinga, 2006; Vishwanath and Scamurra, 2007; Lettieri, 2009; Hellman, 2010; Kumar and Aldrich, 2010; Alkraiji, Jackson and Murray, 2013; Jamoom *et al.*, 2014)
Lack of an information management plan (strateg)	6	(Al-Shorbaji, 2008; Mogli, 2012; Wahabi and Alziedan, 2012; Zaher, 2012; Alkraiji, Jackson and Murray, 2013; Khalifa, 2013)
Lack of leadership support	6	(Al-Harbi, 2011; Alsultan *et al.*, 2012; Wahabi and Alziedan, 2012; Zaher, 2012; Khalifa, 2013; El Mahalli, 2015)
Lack of adequate policies and procedures	6	(Davidson and Heslinga, 2006; Khoumbati, Themistocleous and Irani, 2006; Vishwanath and Scamurra, 2007; Hellman, 2010; Alkraiji, Jackson and Murray, 2013; Shu *et al.*, 2014)
Lack of clinicians engagement and collabration	5	(Al-Shorbaji, 2008; Altuwaijri, 2008; Khudair, 2008; Mogli, 2012; Alkraiji, Jackson and Murray, 2013)
Long time for HIT implementation	4	(Al-Harbi, 2011; Zaher, 2012; Khalifa, 2013; Hasanain, Vallmuur and Clark, 2014)
Lack of awareness	4	(Mogli, 2012; Wahabi and Alziedan, 2012; Zaher, 2012; Khalifa, 2013)
Loss of productivity	3	(Halamka *et al.*, 2006; Jha *et al.*, 2009; Jamoom *et al.*, 2014)
Language issues	3	(Al-Shorbaji, 2008; Hasanain, Vallmuur and Clark, 2014)
Lack of motivation to learn and train	1	(Khalifa, 2013)
HIS add more work/need more time/effort	1	(Khalifa, 2013)
No manuals or guidelines for using HIS	1	(Khalifa, 2013)
Environment	**No**	**Reference**
National healthcare system/ lack of national infomration standards/ Lack of a national plan for medical data exchange	5	(Mourshed, Hediger and Lambert, 2006; Al-Shorbaji, 2008; Altuwaijri, 2008; Khudair, 2008; Alkraiji, Jackson and Murray, 2013)
Market Uncertainties	4	(Davidson and Heslinga, 2006; Lettieri, 2009; Alkraiji, Jackson and Murray, 2013; Hasanain and Cooper, 2014)
The absence of a National Regulator	3	(Alkraiji, Jackson and Murray, 2013; Khalifa, 2013; Hasanain, Vallmuur and Clark, 2014)
lack of clear pricing between government, companies and individuals	1	(Mourshed, Hediger and Lambert, 2006)
Human	**No**	**Reference**
User Satisfaction	1	(Mogli, 2012)
Negative beliefs about their ability to use HIS	1	(Khalifa, 2013)
Ease to use	1	(Khalifa, 2013)

2.4.5 Analysis of Saudi CDSS Acceptance Publications

Table 2-7 presents the four studies found on Saudi CDSS acceptance. They focus on measuring the degree of implementation success and user acceptance. Almutairi *et al* (2012) explained the reasons behind the low number of publications in Saudi context in this area. He emphasised that all the selected hospitals were not mature, and systems were missing many essential additional CDSS features like allergies and cross allergies, drug-food interactions, and drug-lab interactions that were aligned with the Healthcare Information and Management Systems Society (HIMSS) guidelines. This would reflect the situation in most MoH hospitals.

Alghaith and Saddik (2010) reported exploration of the willingness and acceptance of CDSS by dentists. A questionnaire was administrated in the cross-sectional study at the dental department of the Riyadh Military Hospital. The study findings supported correlation between the factors of the tested hypothesis in the UTAUT model. The acceptance and further use behaviour of the system was tested. The study result showed that expectancy of performance did not show significant correlation with behaviour intention, in contrast of other researchers that reported high effect of performance expectancy on behaviour intention. Furthermore, social influence had no significant correlation but effort expectancy shows significant positive correlation.

Table 2-7 The reviewed studies on CDSS acceptance among healthcare professional on Saudi hospitals

Authors, Year	Technology/ Platform	Subjects	Sample/ Used	Method	Key Findings
Alghaith and Saddik (2010)	CDSS	Dentists	100/30	UTAUT variables	Effort expectancy is the only factor that had a significant correlation with the behaviour intention.
Almutairi et al (2012)	CPOE + CDSS Execl	All healthcare team	3 hospitals preliminary study	201 Self administration questionnaires	Three hospitals in Riyadh and found that CPOE and CDSS were not mature yet because there were many challenges, including the high cost to buy or customise these two systems and the lack of qualified health information professionals.
Omaish, Abidi and Abidi (2012)	CDSS for Acute Coronary Syndrome (ACS)	Physicians	-	They present a healthcare knowledge management approach, using semantic web technologies	Can provide helpful recommendations to physicians and prioritise recommendations according to the strength of the evidence.
Khalifa (2014)	CDSS	Physician	Survey KFSH&RC Jeddah	-	Recommendations were categorised into ten main topics that should be addressed during the development and implementation of CDSS knowledge management tools in the hospital.

2.4.6 Saudi HIT Acceptance Factors

This research is designed to assess Saudi nurses acceptance of HIT, practically COPE combined with CDSS. There is a limited number of researches that study the combination of COPE with CDSS, while some aspects of healthcare technology were studied in relation to TAM. Most of the reviewed studies were from USA and Europe. In the developing countries, there is investments in e-healthcare in addition to significant growth in healthcare technology, yet, there is still limited published studies from countries like Saudi Arabia.

From the previous four analysis, acceptance factors considered as relevant to the Saudi nurses context were selected. The selected factor and sub-factors can all be considered as critical factors in various scales. Some factors have no sub-factors like “Human Capacity” which is located underneath the Human context. Meanwhile, the environmental context has more than one factor and many sub-factors. For example, “Regulatory” have two sub-factors “National Healthcare System” and “Market Uncertainties”. The factors are highlighted (in Blue) and sub-factors are (in Grey) based on the author’s understanding and critique of the reviewed literature.

2.4.6.1 Technology Factors

Based on literature review, four technology factors have been selected. They are: HIT strategy, IT infrastructure, Interoperability, Information and Data. Figure 2-3. Each factor generates further sub-factors.

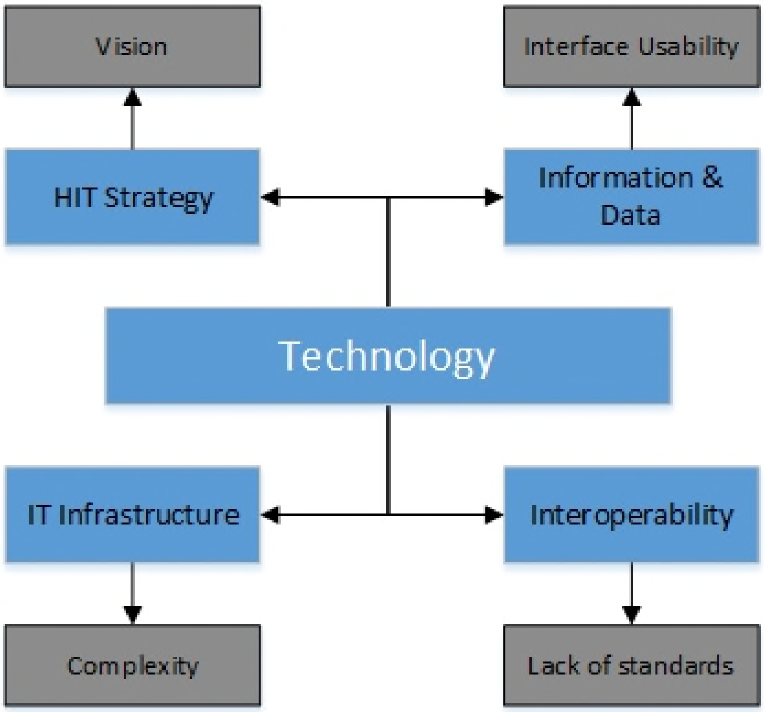


Figure 2-3 Technology factors for HIT adoption

2.4.6.2 Organisation Factors

Scholars have started to focus more on organisational issues because of the high number of e-health initiatives failure that do not achieve their goals. Although a wide range of factors are important to consider in the organisational context, this research focused on two main organisational factors: Top Management and Organisation Culture as shown below in Figure 2-4. Each factor generates further sub-factors.

Figure 2-4 Organisation factors for HIT adoption

2.4.6.3 Environment Factors

Based on literature review, three environment factors have been selected. They are: Regulatory, Economic as well as the Cultural aspects (see Figure 2-5).

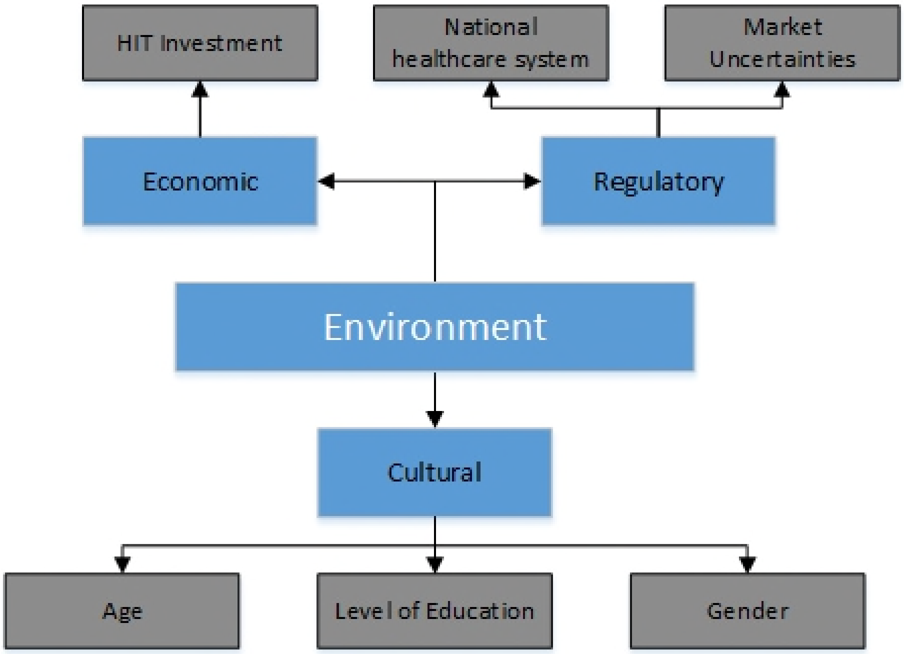


Figure 2-5 Environment factors for HIT adoption

2.4.6.4 Human Factors

Literature review shows human is a critical context when considering adopting and implementing any technology innovation in healthcare organisations. This research focus on two main Human factors: System Use and Human capacity. (see Figure 2-6).

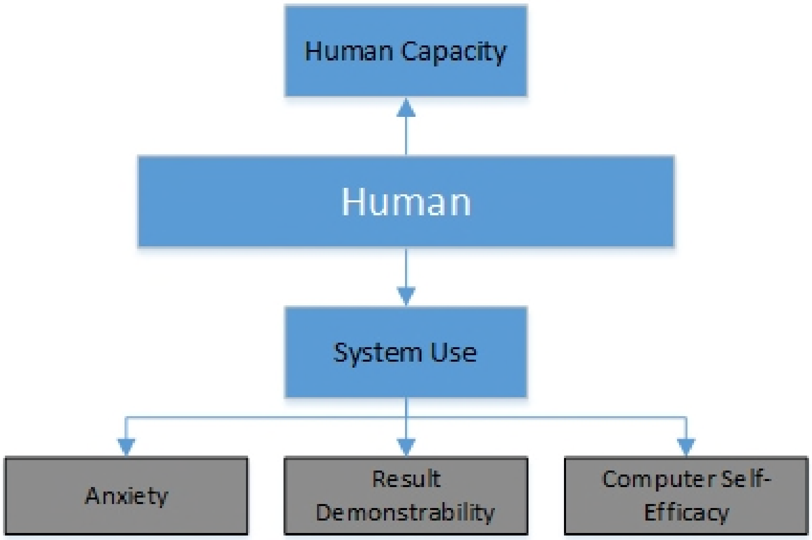


Figure 2-6 Human factors for HIT adoption

These factors contribute to the Initial Framework in Section 4.4, Diagram 4.4

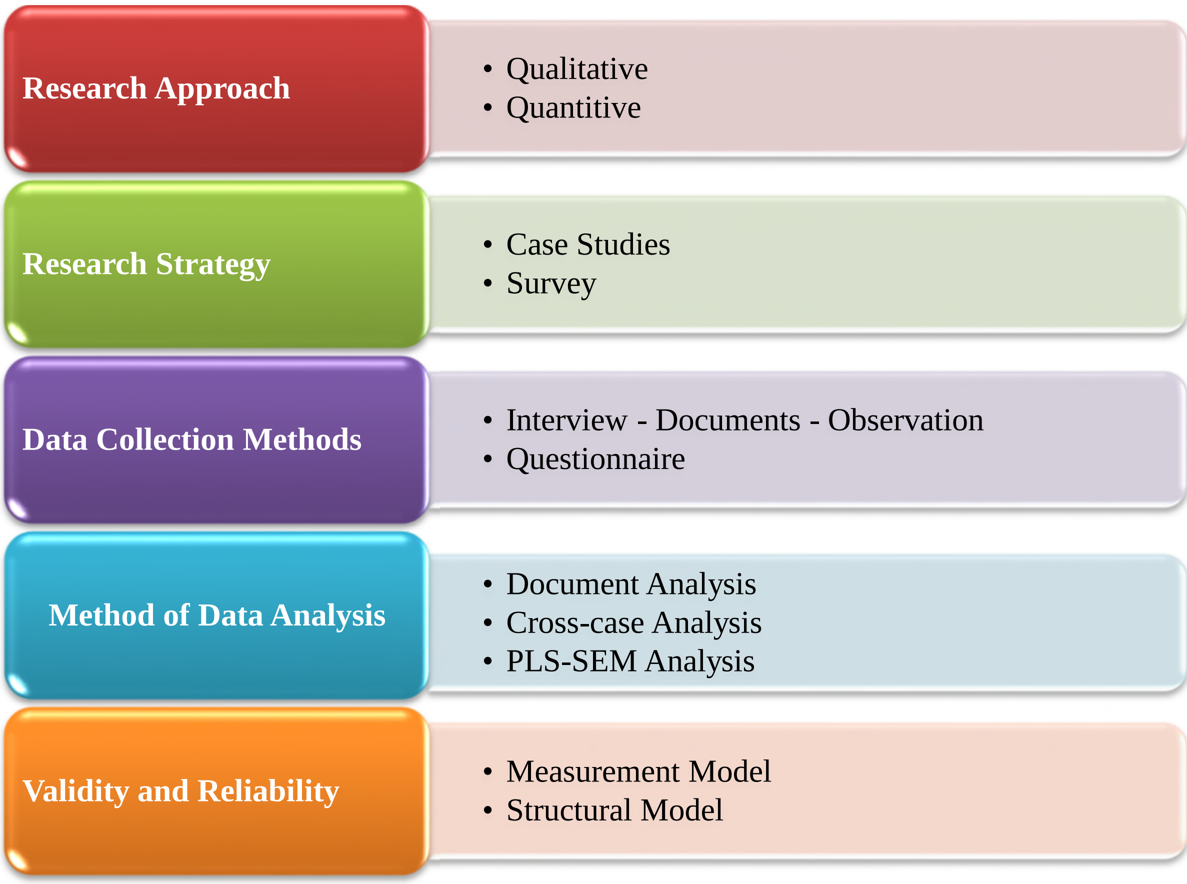
3 Research Methodology

3.1 Introduction

This chapter addresses important choices, resources and information regarding the research design principles. There are options in research approaches and techniques in the research design. The choices made in the methodology of this study are related to the research aim and research problem.

This chapter presents an overview of the research methodology and its structure, which include research approach, research strategy, methods of data collection, sampling techniques, and method of research analysis. Figure 3-1 shows the current research methodology stages.

Figure 3-1 Research methodology stages



3.2 Research Approach

There are three well-known types of research approaches: qualitative, quantitative, and mixed methods. The mixed approach is a combination of the qualitative and quantitative methods. The choice between these three types depends on nature of the research and how to achieve the research aim and objectives. The qualitative method is best suitable when the main objective of the research is to improve the understanding of a phenomenon (Royse, 2007). Furthermore, Cassell and Symon (1998) explain that the qualitative method is preferred if the research question is concerned with organisational processes. Quantitative approach is a technique used in researches in order to collect quantitative data or information that are related to figures and measurement. Thus, quantitative studies depend on collecting quantitative facts by different means of methods (Easterby-Smith, Thorpe and Jackson, 2012).

In this study, the researcher adopted mixed approaches because of the nature and aim of the current research. Using mix method as confirmed by Kaplan and Maxwell, (2005) will help to gain in-depth understanding and richness of the research to gain deep understanding of HIT in Saudi Arabia among nurses and allow for generalisation of study results.

3.3 Research Strategy

There are many research strategies that have been identified with different criteria and explanations, for example, experiment, history archival analysis, biography, phenomenology, grounded theory, ethnography, survey and case study (Creswell, 2009; Robson, 2011). The choice of which strategy to follow is dependent upon the nature of the research problem (Robson, 2011)

Yin (2009) defines a case study as an: "empirical inquiry that investigates a contemporary phenomenon within its real life context, especially when boundaries between phenomenon and context are not clearly evident". Case study enables generalisation on the topic being studied, indicating the idea that 'if it is valid for this case, it is valid for all (or many) cases of a similar nature'. Collis & Hussey (2003) considers case study as an ideal methodology when a holistic, in-depth investigation is needed and when there is a lack of knowledge. Furthermore, case study research is the most widely used qualitative research method in information systems research, and is well suited to understanding the interactions between information technology related innovations and organisational process (Orlikowski and Baroudi, 1991).

Benbasat (1987) states three reasons why case study is an appropriate strategy when researching in information systems:

1. It enables the researcher to understand the nature and complexity of the processes taking place.
2. It allows the researcher to study IS in its natural settings.
3. A case study approach enables a researcher to gain valuable insights into new topics emerging in the rapidly changing IS area.

In this research, a multiple-case study methodology was selected and it is expected to help develop in-depth understanding of the phenomena of HIT adoption among nurses in Saudi hospitals. The technical, organisational, environmental and human aspects interrelated in the HIT adoption process will be examined, making these issues more explicit.

According to Yin (2009), a multiple-case study strategy is appropriate when the aim of the study is to develop a theory that permits cross-case analysis, a necessary feature if the developed theory is to allow widespread generalisation. In this research multiple data collection methods are used as long as they are available (Yin, 2008).

3.4 Justification of Case Studies' Selection

The criteria for selecting the organisation for the purpose of the case studies is described in the following points:

- ***Valuable data and information:*** the organisations selected are well-informed about e-health and its related polices and challenges. Therefore, staff were aware about HIT current status and were willing to share information regarding current barriers and future implications. This was expressed in terms of words or text resulting in sufficient amount of documentary data in papers and reports.

- ***Type of organisation:*** the organisation involved in this case study are considered amongst the top healthcare providers in Saudi Arabia given their advanced IT infrastructures and premium patient care. They are also served by qualified personnel in both IT and health informatics and usually run a high IT budget. However, they were at different levels of adopting HIT at the time of investigation.
- ***Ease of access:*** Finally, as faced by many researchers during data collection in Saudi Arabia (Altameem, 2007), this research also experienced difficulties with collecting data. To overcome these difficulties, the researcher applied two techniques. First, he used personal contacts to organise meetings with organisations and individuals involved in the research, and to obtain documentation. Using personal relationships is a key element to create an appropriate climate with the respondents, which could result in them being more responsive. Second, official letters were obtained from his sponsor the Royal Embassy of Saudi Arabian Cultural Bureau in London and from his supervisor at Cranfield University. These letters were given to the selected organisations in order to gain access and perform the necessary data collection. The researcher faced delays, rescheduling of meetings and interruptions while performing the interviews. Delays and delayed appointments were expected since senior personnel and managers are very busy people.

3.4.1 Prince Sultan Military Medical City (PSMMC): Case Study Hospital

The Prince Sultan Military Medical City (PSMMC) is one of the important hospitals in Saudi Arabia established in December 1978 by the Medical Services Department of the Ministry of Defence. It's main goal is to supply all kinds of healthcare for Ministry of Defence members by offering excellent services, and provide qualified education and engage in all opportunities of medical research. The goal of PSMMC is to succeed excellence in all departments around Saudi Arabia. PSMMC has been developing in the number of facilities, dispensaries and extended to 1450 beds and 7179 staff. It is considered the main supporter of e-health initiatives for the exchange of health information through the pilot project with the Council of Health Services.

The Health Informatics Department is an initiative by the PSMMC authorities to illustrate the importance of medical information by excellent healthcare and medical facilities. This department aims to deliver medical information infrastructure to support the hospital with reliable and accurate information. However, some PSMMC HIT infrastructure was approved 30 years ago and are still under development. Because of the legacy of the system, vendor support had ceased and little modification is allowed. In addition, the HIS system is difficult to understand and manage due to the embedded database format.

The IT department was directed to replace all the legacy HIT infrastructure systems with the latest clinical information systems and increase medical services qualities. However, the MSD runs more than 30 hospitals over the Kingdom of Saudi Arabia. It was considering to adopt an EMR system in all its hospitals to have a central medical records database, thus decreasing effort and cost. Nevertheless, the project is still in the early stage and progress is slow. There is unclear organisational structure also no leader of this project. There is a deficiency of adequate policies and processes. Besides, there is a lack of experts to lead and manage this project while it really needs a team from specialists in IT, biomedical engineering and health informatics, as well as radiologists, pharmacists and doctors. Additionally, it requires a huge budget.

3.4.2 Heraa Hospital: Case Study Hospital

Heraa Hospital is located in Makkah city and it was established in 1984. The hospital has the capacity of 277 beds. The hospital is updated with all activities and procedures in conformance to the standards of quality and looks forward to achieving the accreditation of local Central Council. It is also committed to comply with the standards of national hospitals Central Board for Accreditation of Healthcare Institutions (CBAHI) and to achieve international accreditation by standards Joint Commission International (JCIA).

The hospital employs and attracts highly qualified personnel and based the provision of medical services with a constellation of doctors, consultants and specialists of not less than degree scientific fellowship or highly experienced doctoral. The health services are provided through health team with at least bachelor's scientific degrees in the disciplines of nursing, radiology, laboratory, respiratory therapy, anaesthesia.

Regarding the use of technology, the hospital is planning to activate the ERP system to increase efficiency of administrative control and reporting, financial and operational. The ERP will also help to manage different departments in a unified way reflecting on the quality of medical work and minimising the possible errors.

3.5 Research Design

The empirical design developed for this study is based on six steps. These steps are: formulate research problem, review the literature, HIT implementation issues model, Nurses Acceptance Model, and validation as shown in Table 3-1. The following sections describe each step.

Table 3-1 Research plan in details and model development

Main study		Tasks	By	Output
Stage 1	**Research Definition**	Research Background	Define research areas, research problem, objectives and scope	Research Context and Aim
Stage 2	**Literature review**	Review previous study	1. HIT implementation 2. Review the acceptance study related to nurses	HIT Implementation Issues Framework Extended TAM3
Stage 3	**HIT Implementation Issues Framework** (Initial Study)	PSMMC (Problems in Pharmacy Automation system)	1. Interview 2. Observation by using Business Process Model and Notation (BPMN) 3. Documentation	HIT Adoption Barriers (Published Paper)
		Heras Hospital (Delayed Dispensing Discharged Medication)	1. Failure modes and effects analysis (FMEA) 2. Ishikawa Root Cause Analysis	HIT Implementation Barriers

Stage 4	**HIT Implementation Case Studies**	Nurtal and Pharmatal System Implementation (Communication System) CardioPulmonary Resuscitation (CPR) System Implementation	1. Quasi-Experimental 2. Experimental	Nurtal and Pharmatal System Implementation (Published Paper) CPR System Implementation (Submitted Paper) Refined HIT Implementation Issues Framework Extended TAM3 Model for Nurses
Stage 5	**Nurses Acceptance Model**	Testing the nurses' acceptance and intention behaviour towards the use of HIT systems	1. Questionnaires to 2 implementation projects 752 responses 2. PLS-SEM 3. Cross-case analysis	Nurses Acceptance Model
Stage 6	**Discussion and Conclusion**		Future work	-

3.5.1 Stage 1: Research Definition and Identifying the Research Problem

The initial stage of the research was to explore the research areas and research problem in order to define aim, objectives and research scope. Firstly, the research was started by exploring HIT issues in healthcare organisations and how these systems help to reduce medication errors. Also, nurses are considered to be on the frontline of medical care and make up the largest proportion of the workforce in hospitals. Since the research aim is "to investigate the critical factors that influence the acceptance of Health Information Technology among nurses", it is argued that discussing the nurses' behaviour would improve HIT adoption. The main objective of this research is to develop a “Nurses Acceptance Model” that can effectively recognise the adoption behaviour and use of nurses. This research is expected to positively influence the hospital management toward taking appropriate decisions to achieve successful HIT adoption. Saudi Arabia was selected as the evaluation context due to three reasons, firstly the author is sponsored by Saudi government; secondly the author believes that data collection and findings contribute to e-health initiates in the country and support the efforts in HIT implementation; and thirdly due to the author’s work experience and career's prospective to remain in the country context.

3.5.2 Stage 2: Review the Literature

The literature related to the field of health information systems and other relevant areas was reviewed. This included background, definitions, current status and challenges of health informatics in Saudi hospitals. More importantly, a review of technology acceptance model study related to nurses is carried out in addition to a deep review and analysis of the key barriers surrounding the user adoption of HIT. The resources used are combined from books, academic papers, research reports and trusted websites. The main sources used are “ScienceDirect” “ProQuest”, “SAGE”, “Web of Science”, “EBSCOhost”, “Emerald Insight”, “PubMed”, “Google Scholar”, “IEEE Xplore” and “Scopus”, which are available from the Cranfield University Library. The search is on topics like ‘theory’, ‘adoption’, ‘acceptance`, ‘nurses’, ‘medication errors’, ‘TAM model’, `TOE framework`, `Saudi Arabia`, and combinations of these and other keywords (like: ‘user acceptance’, `TAM model`, ‘CDSS adoption’ and ‘CPOE adoption’). At the end of the review, gaps and unknown situations are found. The duration used for searching the articles was between 1980 and 2017 and limited to related subjects, articles in English, full-text articles.

3.5.3 Stage 3: HIT Implementation Issues Framework (Conducting the Initial Study)

Identifying the research problem and reviewing the related literature enabled the development of the initial conceptual framework. It was important to understand the actual situation about HIT implementation in Saudi hospitals. The step aimed to identify issues related to the technology, organisation, environment and human aspects and how they interrelate in the communication between hospital staff via using hospital HIT. This helped to build an initial picture about the context of the hospital systems and address the critical issues and factors that could be affecting implementation and use of HIT. The matching between the initial findings from the initial study with the literature reviewed subsequently helped to clearly identify the research problem.

The author highlighted a number of advantages of using the H-TOE framework as the basis for the current research.

- The aim of this stage was to build a holistic picture by proposing a H-TOE framework as initial study to understand the influencing factors that lead to nurses decision to adopt HIS.
- The H-TOE model is in line with the research design, as this research is conducted at two levels: organisational and individual. The organisational level measured barriers and influential factors to HIT adoption by nurses. The individual level inspired the study and create the factors on TAM model.
- Finally, The H-TOE is flexible and accepts modification and expansion to add more categories or factors to the model. This allowed the author to add multiple levels of factors and adapt the framework according to the findings of the study.

This stage involved two case studies, both in tertiary hospitals. Saudi tertiary hospitals were selected as case study for reasons including the fact that they are equipped with good IT infrastructure and employ HIT in addition to their future plan to overcome current implementation problems and improve the level of connection among health information systems. Staff and healthcare professionals were accessible and willing to share their views. The data collection stage ran from June to October 2013 in PSMMC as shown in Table 3-2. Then, data was collected from the Heraa Hospital during the period from October to November 2013. This hospital was compatible to PSSMC standard and selected to extend the generalisation.

Table 3-2 Summaries the case study

Study	Method of Data Collection	Analysis Type
Prince Sultan Military Medical City (PSMMC)	Semi-structured Interviews Documentation	Relationships analysis
	Observation	Business Process Model (BPMN graphical representation)
Heraa Hospital	Observation and focus group	Failure modes and effects analysis (FMEA) and Ishikawa Root Cause Analysis

The study was conducted using open-ended interviews, which took place in the pharmacy, wards, IT department and administration offices. The data gathered from the observation was used to build a business processes model and to capture the problem from the researcher's own observation. Additional data were meeting documentation, e-mail correspondence (correspondence between project team members), future plans, website, and reference materials available on the Internet. These sources were then analysed using content analysis, BPMN, failure modes and effects analysis (FMEA) and Ishikawa Root Cause Analysis (Fishbone Diagram). The detail of the analysis and the results is described in Chapter 4.

3.5.3.1 Interviews

The interviews' main objective is to define the hospital's main features as well as to develop knowledge regarding the major obstacles. It started by discussing general background, moving to business and technical issues as it gets deeper. (See interviews questions in appendix A). All the interviews was conducted in person to achieve a good contribution from experts where suitable individuals can share his insights in the research and tell his/her unique story. Face-to-face semi-structured interview is selected as the dominant form. Table 3-3 summarised the interviews.

There were three levels of interviews:

- **Exploratory Interview**: initial interview aims to get an overall understanding of the project, department and the interviewee's work. This usually lasts for about 30 minutes.
- **In-depth Interview**: the interview is concentrated on the actual experience with using the new system and on the assessment of the implementation process as well as the quality of the system itself. The interview usually lasts for 1 – 2 hours.
- **Interview to correct record**: this interview aims to correct BPMN workflow and it lasts for 1 – 2 hours or by email.

Table 3-3 The interview of the research

Name	Interviewee’s Position	Time	Record
Participant 1	Head of the pharmacy automation team	2h & 49 min	Yes
Participant 2	Informatics' pharmacist	10 Days	Yes
Participant 3	Senior Information System Architect and Manager of Data Warehouse	1h &16min	Yes
Participant 4	Systems analyst	1h &10min	Yes
Participant 5	Database Administrator	1h & 30min	No
Participant 6	Nurse responsible for Pyxis	1h & 5min	No
Participant 7	Reception team	45 min	No
Participant 8	Vendor (head of maintenance team)	2h &10min	Yes

3.5.3.2 Documentation

The author is keen to collect all available documents due to their advantage of being stable and can be reviewed repeatedly This material is important to cover any gaps that may exist in the interviews, as well as to validate the data gathered in the interviews. Table A-4 summarised the documents collection.

3.5.3.3 Observation

The aim of this source was to build a business processes model and to capture the problem from the researcher’s own observation. The Business Process Model and Notation (BPMN) allows the business processes to be represented and analysed to identify the HIT problem. The observation phase used three kinds of sources:

- **Formal meetings:** these meetings were held with departments involved in the adoption and use of HIT. 1. *Health informatics people*: The aim was to draw the borders of the workflow and describe the processes involved, and to define all the issues during and after the adopting of the new HIT. 2. *The IT department team*: the next step was to focus on the infrastructure level and discussed problems related to the software (databases, languages and mapping) and the hardware (networking). The details related to the research’s purpose was added to the business processes’ model. 3. *The end user*: the final step was to get feedback about using the system.

- **General observation** this step aimed to understand the business workflows in the hospital from inpatient arrival at reception until medication is received.

3.5.4 Stage 4: HIT Implementation Case Studies

Throughout the research, the research methodology was revised and improved to support the research aim. The outcome of the first stage led the researcher to concentrate on the study factors that influence nurses' acceptance or rejection of HIT. In particular, understanding the barriers and challenges surrounding the adoption of HIT was useful in creating the nurses' adoption level. Data was collected from multiple implementation case studies, and analysed to refine the final revision, as shown in Table 3-4. After completing the individual "within case study analysis", each of the two case studies should be cross analysed against the other two cases. Cross case analysis gave a deep understanding and explanation of the phenomena; and increased generalisability.

Table 3-4 Implementation of the case study

Hospital	Implementation	Methods	Analysis Type
PSMMC	CardioPulmonary Resuscitation (CPR) System Implementation	Quasi-experiment	Pre-post testing
	Nurtal and Pharmatal System Implementation (Communication System)		

The H-TOE framework and extending TAM3 model were modified and reported in Section4.4.

3.5.5 Stage 5: Nurses Acceptance Model and Model Validation

This stage studied the factors that influence the nurses' intention to accept or reject of HIT. A sample of near to 2800 nurses working in PSMMC was selected and questionnaires based on the extended TAM3 model were sent to them. The self-administered questionnaire method was chosen and employed for this study. The data gathered were entered into the computer through the statistical package (SPSS) for data screening and then analysed by using Partial Least Squares Structural Equation Modelling (PLS-SEM) (SmartPLS) as shown in Table 3-5.

Table 3-5 Summaries of the data collection

Study	Method of Data Collection	Analysis Type
PSMMC	Survey (Questionnaire)	Partial Least Squares Structural Equation Modelling (PLS-SEM)
	Between the implementing the two case studies	Cross case analysis

3.5.5.1 Questionnaires

3.5.5.1.1 Questionnaire Design and Development.

The questionnaire (see Appendix D, E and F) was developed based on the Initial Framework reported in Section 4.4 and used a Likert scale adapted from Davis (2008). A Likert scale is appropriate when the research needs to measure the respondent's attitude towards constructs (McDaniel & Gates, 2006). The research questionnaire consisted of a cover letter and three pages of questions. The cover letter explained the aims of the study and contact details for the researcher and the supervisors' team. The questionnaire was written carefully using clear and simple language to encourage participants to express their viewpoint freely and was divided into three parts. Part one collected demographic information about the respondents. Part two contained statements which measure the attitude towards about HIT in the PSMMC. All the statements were measured according to a seven point Likert-type scale. The possible responses were: 1 = strongly disagree; 2 = moderately disagree; 3 = somewhat disagree 4 = neutral; 5 = somewhat agree; 6 = moderately agree and 7 = strongly agree. Part three of the questionnaire included the open-ended questions. The open-ended questions were a way of asking in-depth questions, and the answers provided further explanations and a clearer understanding of the findings from the model questions (Collis & Hussey, 2003).

After producing successive drafts of the questionnaire these drafts were repeatedly discussed with several academics who have extensive knowledge of IT adoption and healthcare informatics until the final questionnaire draft emerged.

3.5.5.1.2 Piloting the Questionnaire

Before launching the survey, the questionnaire was piloted to ensure the accuracy, clarity and simplicity of the questions. This step was vital because it could highlight new issues or problems that require consideration and inclusion in the questionnaire itself (Gray, 2013).

The questionnaire was piloted by two different groups: nurses and pharmacists. The paper surveys were put in the pigeon holes of in nurses and pharmacists room. The respondents participated in the pilot were not invited to participate in the final study as this may influence the later behaviour of the respondents if they have already been involved in the pilot study (Holborn, Langley and Burrage, 2013). There were no missing data in the questionnaires confirming that the questions were easily comprehensible to the respondents. The responses were analysed according to their group type. Table 3-6 shows the type of groups and their responses.

Table 3-6 The type of group and their responses

Group Type	Number	Returned	Percentage %
Nurses	20	5	25
Pharmacists	20	5	25
Total	40	10	25

The average time spent in filling the questionnaire was 15 minutes. To avoid having too long a questionnaire that may affect the response rate, some of the questions regarding the adoption process were removed. The following summarise the changes made from the feedback of the pilot:

1. Rewording of some questions and instructions. These questions are CES1, BI1, BI2, USE3 and CANX4. For example, Computer Anxiety construct question CANX4 “NURTAL system makes me feel uncomfortable” “” was found unclear because the word uncomfortable seems to be general. The question was changed to “I feel apprehensive (anxious) about using the NURTAL system”.
2. Rearranging the sequence of some questions. For example, the questions CSE and PLAY were created in specific sections for more clarity and understanding.

3. Adopting the seven-point scale except in computer self-efficacy, as the 10-point Guttman scale was found to be confusing.
4. Busy time and difficulty to access the Internet at work resulted in low response rate, therefore self-administered paper questionnaire method was used in the main study.

The pilot also confirmed that the questionnaire did not need to be translated into Arabic or any language, since the questions were understood easily in English language by all participants.

Based on the above, the questionnaire was reconsidered and corrected, and a final version was created as seen in Appendices D, E and F.

3.5.5.1.3 The Population

The population of the research is the complete number of potential groups or features that the researcher demands to include in the study (Gray 2009). The population of this study consists of three individual groups: around 400 nurses who are using CPR system in paediatric departments (16 wards) and all the nurses around 2800 working in wards (52 wards) around the hospital that uses the Nurtal and system in PSMMC hospital. Also, around 65 pharmacists using the Pharmatal system in 5 pharmacies. The wards include for example General Paediatrics Unit, Oncology Unit, Neonatal Intensive Care Unit(NICU) and Paediatric General Intensive Care. The researcher was present most of the time for explanation and collecting completed questionnaires to help maximise the response rate.

SEM as used in this study requires a sample size that represent either 10 times the number of items that reflect the most complex construct (Chin, 1998) or the largest number of independent variables that affect a dependant variable that can be greater (Barclay, Higgins and Thompson, 1995). In this research, a minimum of 90 responses were needed to allow data analysis via the component-based SEM statistical method. For the Pharmatal system, the number of usable responses from pharmacists after removing missing data (unanswered questionnaire) and data cleaning was 47 participants. Thus, Pharmatal system did not meet the minimum sample size for PLS-SEM analysis, and only the two groups of nurses were used,

3.5.6 Stage 6: Drawing Conclusion

The final step of the research design is to draw conclusion and wrap up all the main findings as well as to suggest direction and guidance for future work.

3.6 Ethical Approval

The research participants were nurses, pharmacists and staff of PSMMC. Approval from the PSMMC Ethics Review Committee (ERC) was gained before the start of the research.

PSMMC ERC has the statutory duty to safeguard the dignity, right, safety and welfare of all actual or potential research participants and/or communities. The ERC is mandated to review research protocols and the supporting documents on their scientific and ethical merit. Furthermore, the ERC is mandated to assure that proposed research directive according to governmental and institutional policies and regulations. The functions of ERC included but not limited to

1. Develop research review guidelines and standards.
2. Protocol review to give final decisions on all research proposals submitted by investigators including multi-centre collaborative such as student theses (M.Sc., PhD., specialisation).

The ERC was created under aegis of national and local health administrations, and national (or centralised) medical research council.

The PSMMC Head of Pharmacy was the PSMMC named internal investigator in this research. The research proposal was submitted to the ERC for review. The proposal included the Investigator's Undertaking (SOP29) which assumed the following duties and responsibilities:

1. The investigators will be jointly responsible for all technical, ethical and administrative aspects of the research involving human subjects, and humane treatment of laboratory animals if required to be used during the course of this research project.

2. The investigator will furnish the Director of Scientific Research Center with a report on the progress of the research project once every six months.
3. Upon completion of the research project, the investigator will submit a summary of the results, objectives achieved and benefits which the Kingdom of Saudi Arabia shall gain from this research project.

The investigator obtained the departmental approval for undertaking the research study and submitted three forms (SOP 30) to the ERC.

The ERC careful examined the research protocol, the history of the researcher and the readiness of departments. A number of comments and clarification about research proposal were made before the ERC before the research team received the ethical approval See Appendix L.

Participation in the survey was voluntary and anonymous and all personal data were removed (if any) to reassure the participants about the confidentially and protection of data. All participants were informed about the researcher's topic and how this study may help to advance the quality of patient care at PSMMC and improve decision making in pharmacy and nurses departments to provide more efficient and effective services. The contact details of the researcher and supervisor were given in the cover letter. In addition, if respondents have any ethical concerns, the ERC contact details were provided too.

All head nurses received an official email from director of PSMMC nursing department provided the necessary information about the research and its aim. In same time, the nursing administration encouraged the nurses to participate in the study. Finally, the directors of pharmacy and nurses were provided of final result at the end of the study.

All data collected remained in a locked environment and electronic security was maintained on the researcher private laptop computer through the use of passwords. Information was only shared with his supervisor for the analysis the information. After completing the research project, the data collected will be destroyed.

4 Implementation Issues Framework for HIT Adoption (Initial Model Development)

4.1 Introduction

This chapter reports on the qualitative case studies to add the Saudi HIT context understanding to the H-TOE model derived from literature. There were two studies in this phase, and each study is reported in details with the purpose, methodology, results and findings. The findings were used to determine the various circumstances of HIT adoption in Saudi hospitals and the related problems. At the end of this chapter, the framework of the implementation issues for HIT adoption was built as a result of these studies.

4.2 Problems in Pharmacy Automation System

4.2.1 Purpose

The aim of this case study was to investigate the nature of interoperability problems between the pharmacy system and automated medication dispensing cabinets (ADCs) system after the implementation of the Health Level 7 (HL7) standards in Prince Sultan Military Medical City (PSMMC).

4.2.1 Computer Systems

In 2010, the Inpatient Pharmacy Department started the Profiled Pyxis project. The Pyxis MedStation system was an Automated Medication Dispensing Cabinet (ADC) (Wakefield *et al.*, 2010) which could help to manage medications by automating the process throughout the hospital. Pyxis cabinet were used to store patients' medications in each of the 58 wards in PSMMC.

In 2012, the hospital started the automation project to integrate all the hospital departments, starting with the Inpatient Pharmacy. The sharing of information should result in a higher quality of care and reduced medication costs. The hospital adopted the HL7 health data standard using the Orion Health Rhapsody Integration Engine, a recognised global health informatics solution. After the implementation, the Inpatient Pharmacy began to suffer situations of losing inpatient information. In some occasions, the pharmacist profiled the patient medications into HIS, however, the information did not reach the ADC machine and the nurses could not obtain the patient medications. When this problem happened, the nurses had to spend extra time and effort to manually double check the patient's paper medication prescription with the ADC machine. Sometimes the nurses had to obtain the patient's medication from pharmacy or manual override the ADC which increased the chance of medication errors. These types of medication errors increased the risk faced by the patient in the cases when the medication was not received or not received on time. The hospital attempted different investigations to solve this problem in addition to working with the vendors who provided the system, but solutions were not reached.

4.2.2 Materials and Methods

4.2.2.1 Research Design

The research method was a detailed case study where multiple data collection methods were used to obtain different views and corroborate evidence. The methods included interviews, documentation, business process modelling.

4.2.2.2 Data Collection

Business Process Modelling: This method was used to build a business processes model about the Inpatient Pharmacy and to capture problems from the researcher's own observations. The business process model was built using the Business Process Model and Notation (BPMN). Interviews: Interviews were used to gain a full picture of the hospital as well as understanding the major barriers within the hospital. Documentation: Documentation was collected from the available sources around the project such as agenda, e-mail correspondence, future plans and other personal documents.

4.2.3 Results

The results from the data analysis revealed the nature of the problems experienced in the PSMMC.

4.2.3.1 Business Process Model

The modelling of inpatient pharmacy systems was an essential first step toward a more consistent and comprehensive understanding of interoperability problems, where management and improvements were more easily implemented by health professionals. The processes were modelled using BPMN. The BPMN model scenario comprises of five participants and one system:

- Patient
- Receptionist
- Nurse
- Physician
- Pharmacist
- Pharmacy system

Model Information

- 5 actors
- 2 data objects
- Multiple events, connecting objects and activities

In Figure 4-1 the process starts by the ward receptionist admitting the patient in the ADT system. Then, the nurse looks up the patient's medical record, conduct an assessment (enter the patient height and weight, etc.), then refer the patient to the physician. The physician reviews the patient's record, history and other relevant information, then meets with the patient. The physician then writes the inpatient pharmacy form (IPPF) informing the pharmacists of the prescribed medication. The nurse sends the IPPF to the pharmacy through email. The IPPF is verified by the pharmacist and profiled in the medication profile screen in the HIS. The HIS sends the IPPF information to the ADC Console (server) through Rhapsody (HL7). The medications loaded in the ADC will appear in bold font while those unavailable will appear in dim font for the nurse's information. Finally, the nurse obtains the patient medication from ADC, and non-ADC medications are obtained from pharmacy.

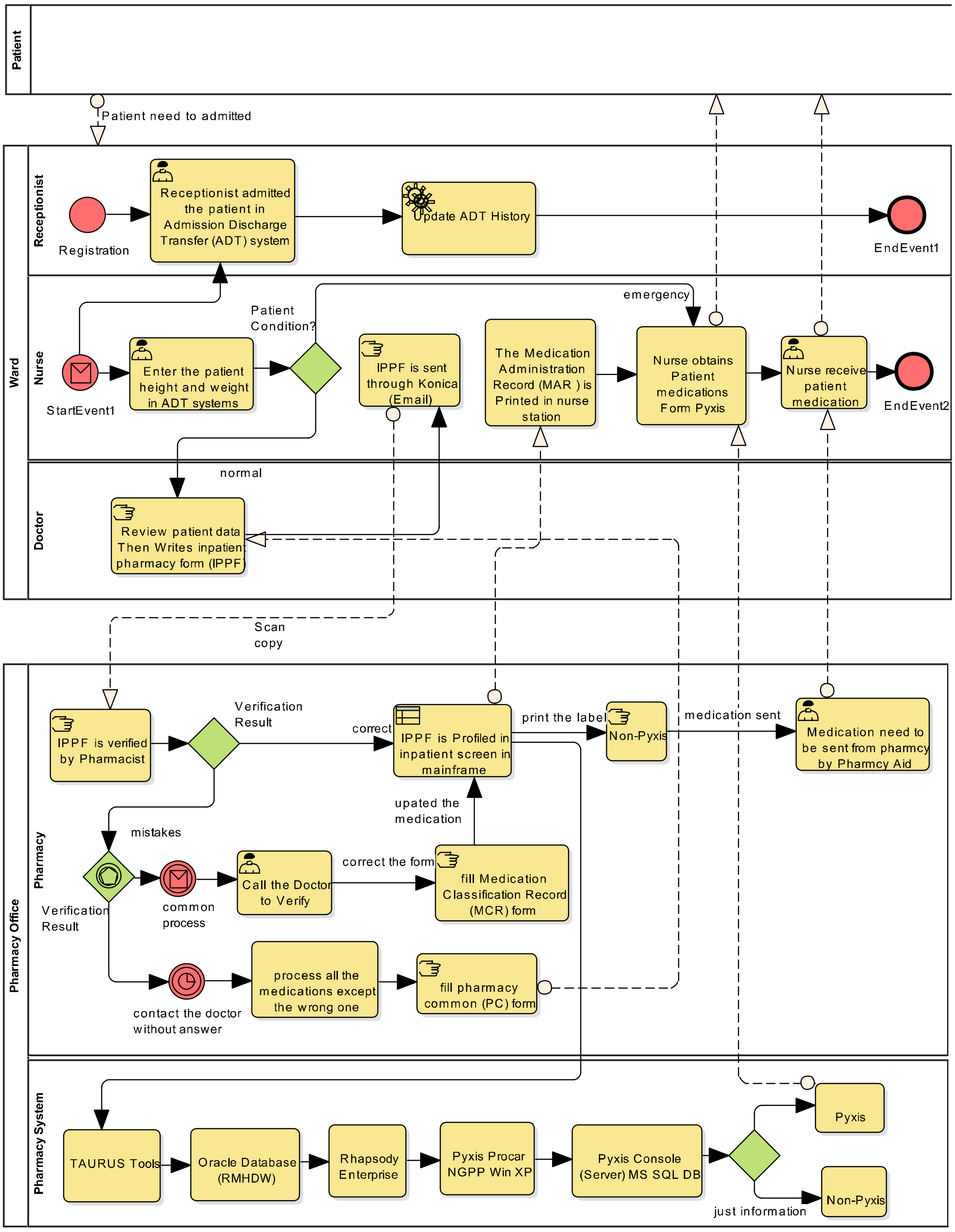


Figure 4-1 BPMN inpatient pharmacy process

The benefit from using business processes model was to identify any problems in the detail operations workflow. The problems identified have different types related to different causes. There were two types of mapping problems between the HIS and ADC systems. First, the process problem in which some work processes were not designed in HIS system and were completed manually, and the semantic problem in which some steps in the workflow had integration issues.

- A part of the admission procedure for children, in PSMMC, is calculating the doses of CardioPulmonary Resuscitation (CPR) medications. The doses were calculated based on the children weight. The CPR medications chart consists of 14 medications, a procedure and the length of Tracheal Tubes. The CPR medications chart was calculated manually therefore, it is highly prone for errors[1].
- In addition, the maximum capacity of patient drug profile was 100 medication transactions for each patient in the HIS. Many patients exceeded this number and caused the loss of medications record. Because of this problem, new medications could not be added in the patient profile therefore increased the chance of medication errors.
- The communication between nursing and pharmacy relied mainly on telephone calls. Communication through phone calls can be a source of interruptions in pharmacy operations[2].
- Pharmacists had difficulty in recognising prescription priority after the prescription was sent by nurses using the imaging system Picture Archiving and Communication System (PACS).
- The inventory system (Oasis) and the HIS were not integrated, leading to the loss of medications inventory tracking. In order to meet the urgent needs of patients in a dynamic healthcare sector, the pharmacy must have an accurate, efficient and real-time medication inventory management system. The benefits of inventory system include but not limited to minimise medications wastage, utilize the pharmacy space and improve the patient outcomes through increasing pharmacist contact time with patients and increase the availability of medications.
- The cancel of discharge code in ADT system enabled the clerks to cancel the patient discharge. However, this code was not defined in the ADC. Consequently, the patient would be considered as discharge patient in

[1] This problem has been solved in section 5.2 CPR System.
[2] This problem has been solved in section 0 Nurtal and Pharmatal systems.

ACD while the patient is still admitted in the ADT system. That caused the disappearance of patient medication from ADC. To overcome this problem the pharmacist has to profile all the patient medications again.

4.2.3.2 Interviews and Documentation

Further investigation into interoperability barriers were analysed by descriptive analysis of the interview results and documentation. E-mail correspondence was analysed by studying the email records that reported failures cases in systems within the project team or between project team and vendor. In this way, problems in the pharmacy system were detected in process mapping. For example, the medication was not appearing at the ADC screen at the expected due time for at least 20 patients. This timing is crucial to alert the nurse and staff of what medication is due at certain time. When the Oracle system was checked, another problem was found related to the dosing interval which disappeared with some patients.

4.2.4 Discussion

In recent years, interoperability scholars have started to focus on non-technical issues in addition to the technical issues. The field study confirmed that barriers identified were mixed between pure technical issues (networks, databases, and software applications), and technology issues (strategy, vision and action plans). Thirteen barriers in Table 4-1 were identified that affect the effectiveness of the PSMMC hospital integration and were classified into three levels (organisational, semantic, technical). This was the result of a five-step analysis. First, the researcher combined all the issues identified in interviews, documents, process modelling and information modelling. Second, the documented data were refined to remove duplication and unnecessary information, resulting in 13 barriers. Third, the researcher started to sort and categorise the barriers into one of the interoperability levels: technical, semantic and organisational. Fourth, the categorised barriers were presented to the members of the PSMMC project group for validation. Finally, the barriers were rated in importance by the PSMMC project group, representative PSMMC staff and the IT team.

Relevant literature that touched on the barriers is also added.

The organisational context is necessary for any IT innovation adoption, including e-health. The analysis of the data confirmed the strong relationship between the adoption of health standards and the identified organisational barriers. For instance, resistance to change has been addressed by all interviewees as a major obstacle slowing the systems' implementation. This barrier is also one of the most common barriers in the region among employees, senior officers and managers (Altuwaijri, 2008; Al-Mudimigh, 2009; Bah *et al.*, 2011; Alkraiji, Jackson and Murray, 2013; Hasanain and Cooper, 2014). Several studies (Halamka *et al.*, 2006; Solomon, 2006) that examined the organisational barriers associated with the adoption of health standards have identified similar factors as in Table 4-1. Pardo Del Val and Martinez (Khalifa, 2013) identified twenty-four different sources of resistance to change in the strategy formulation and in the implementation stage.

Table 4-1 The barriers associated with the adoption of HL7 standard and their importance

Levels of Constructs	Barriers	Importance	Reference
Organisational	Resistance to Change	●	(Halamka *et al.*, 2006; Khoumbati, Themistocleous and Irani, 2006; Solomon, 2006; Kumar and Aldrich, 2010; Alkraiji, Jackson and Murray, 2013; Jamoom *et al.*, 2014)
	Lack of Training	◉	(Khoumbati, Themistocleous and Irani, 2006; Jha *et al.*, 2009; Jamoom *et al.*, 2014)
	Lack of Adequate Policies and Procedures	●	(Davidson and Heslinga, 2006; Khoumbati, Themistocleous and Irani, 2006; Vishwanath and Scamurra, 2007; Hellman, 2010; Alkraiji, Jackson and Murray, 2013; Shu *et al.*, 2014)
	Loss of Productivity	○	(Halamka *et al.*, 2006; Jha *et al.*, 2009; Jamoom *et al.*, 2014)
	Lack of Process	●	(Davidson and Heslinga, 2006; Halamka *et al.*, 2006; Jha *et al.*, 2009; Hellman, 2010; Jamoom *et al.*, 2014)
	National Healthcare Systems	◉	(Hellman, 2010; Alkraiji, Jackson and Murray, 2013)
	Cost	○	(Davidson and Heslinga, 2006; Vishwanath and Scamurra, 2007; Lettieri, 2009; Hellman, 2010; Kumar and Aldrich, 2010; Alkraiji, Jackson and Murray, 2013; Jamoom *et al.*, 2014)
Semantic	Lack of Mapping	●	(Davidson and Heslinga, 2006; Halamka *et al.*, 2006; Bah *et al.*, 2011; Iroju, Soriyan and Gambo, 2012; Alkraiji, Jackson and Murray, 2013)

Technical	Compatibility (Lack of standards)	●	(Davidson and Heslinga, 2006; Halamka *et al.*, 2006; Jha *et al.*, 2009; Kumar and Aldrich, 2010; Alkraiji, Jackson and Murray, 2013; Hasanain and Cooper, 2014; Shu *et al.*, 2014)
	Market Uncertainty	◘	(Davidson and Heslinga, 2006; Lettieri, 2009; Alkraiji, Jackson and Murray, 2013; Hasanain and Cooper, 2014)
	Old Infrastructure	●	(Halamka *et al.*, 2006; Khoumbati, Themistocleous and Irani, 2006; DesRoches *et al.*, 2008; Kumar and Aldrich, 2010; Alkraiji, Jackson and Murray, 2013; Hasanain and Cooper, 2014)
	Shortage of Professionals	●	(Mourshed, Hediger and Lambert, 2006; Hellman, 2010; Alkraiji, Jackson and Murray, 2013)
	Complexity	◘	(Davidson and Heslinga, 2006; Halamka *et al.*, 2006; Kumar and Aldrich, 2010; Alkraiji, Jackson and Murray, 2013; Hasanain and Cooper, 2014)

Note: (●: important; ◘: neutral; and ○: less important). The relevant studies are also highlighted.

The result of the field study was compared with those reported in literature. Most of the major barriers identified in literature were also found important in the field study. For example, resistance to change and lack of training were the top identified organisational barriers (mentioned in 9 studies) and they were also identified from the case study. Cost was also mentioned in both the case study and the literature as many papers (7 papers) stressed on the lack of financial support or the high initial cost of implementation.

The analysis revealed that organisational factors were the most common mentioned barriers to the HIT standards' adoption in both literature and case study. This reflected the importance of considering the organisational factors to ensure successful implementation and in particular resistance to change and lack of training which were found to be the most identified barrier across all levels. As a result, it could be seen that there is a gap between user acceptance and the process of successful HIT adoption. This is supported by (Hameed, Counsell and Swift, 2012) who argued that there is lack of research in considering both IT innovation adoption and user acceptance in organisations. This was because most of the studies only considered factors affecting the adoption of IT until the acquisition of innovation without checking on whether this innovation was developed to be a part of the user's regular practice.

Additionally, studies on user acceptance focused on the behaviour and attitudes of individuals towards the acceptance of an innovation.

Regarding the semantic barriers, mapping issues were not discussed commonly in literature (only three papers). However, some papers discussed the interoperability problem and the importance of developing a standardised system and reach an integration/medical exchange on national level.

4.2.5 Legends of Tables and Figures

Appendix A presents the rest of tables and figures for the Inpatient Pharmacy Automation System implementation.

4.2.6 Key Findings of Pharmacy Automation Study

1. Guideline for hospital system security and possible threats was a requirement. A list of threats could help in guiding the development of a suitable model for hospital system. The study had found that hospital faced multiple electronic attacks and viruses. IT security management was responsible for raising appropriate awareness direction for nurses. More studies were needed to understand the level of information security awareness especially among nurses.
2. After the unproductive implementation, the system faced many failures. In addition, the cost of maintenance system was equal to the cost of acquiring new system.
3. The Inpatient Pharmacy had advanced plans for workflow development e.g. robotics filling for loose tablets and cytotoxic automation. Yet, as the result of the poor implementation, the plans were too inclusive and might be over ambitious.

Table 4-2 showed the pharmacy automation system study factors. The ‘Identified known factors’ column are sub-factors from literature. The ‘New findings from CRP system’ column explained the new sub-factors that were discovered from the current case study. Every factor and sub-factor was checked and verified in every stage to ensure that it included only the most critical elements for HIT adoption. For instance, cost was added from literature, after careful consideration for this case study, it was found that the cost was considered as a low critical factor because Saudi Arabia is one of the richest country and most of its hospital do not worry about implementation costs.

Table 4-2 Pharmacy automation system study factors

Identified known factors		New findings from CRP system
Technology	Vision	Mapping & Integration
		Old Infrastructure
		Output Quality & Accuracy
		Vendor pressure
Organisational	Leadership Support	
Environmental	Level of Education	
	National healthcare system	
	Market Uncertainties	
	HIT Investment	
Human	Anxiety for Pyxis Machine	Loss of Productivity
	Nationality	Shortage of professionals

The factors from this case adds to the Initial Framework in Section 4.4.

4.3 Delay Dispensing Discharge Medications System

4.3.1 Purpose

The project aimed to speed up the delivery of medicines to patients in Heraa Hospital wards to facilitate patient discharge, to improves quality and enhance productivity through reduce delay and enhance the process. The initiative needed to ensure that the improvement was implemented without any increase in pharmacy staffing levels, dispensing error rates or adversely affecting patient safety.

4.3.2 Background

Delays in hospital discharge had been an issue in the Heraa Hospital for many years. Such delays contributed to bed pressures and obstructed patient flow. By 2013, the average prescription times (the time taken for medications to be received by patient after the prescription is written by prescriber) exceeded four hours and the daily average prescription times were highly variable. This situation developed in spite of the partial automation of pharmacy. The Heraa Hospital Continuous Quality Improvement and Patient Safety (CQI&PS) Department reported that delay in dispensing of discharge prescription - also referred to as To Take Out (TTO) in UK - could be attributed to delays in patient's discharge in Heraa Hospital 2013, costing unnecessary charge. Discharge delays created frustration for patients and their families, and healthcare professionals were frequently confronted with complaints regarding such delays. Releasing hospital beds by speeding up the discharge process was therefore a priority. Some hospitals had redesigned dispensing system in an attempt to shorten the discharge prescription turnaround time. An example of these attempts was One Stop Dispensing. In this solution, the patients were encouraged to bring their own medicines into hospital on admission and medicines assessed by pharmacy staff as suitable for use were used for the patient during their hospital stay. A 28-day supply was given of any medicines deemed unsuitable for use, when the quantity of a particular medicine is depleted and then new medicines were commenced (Ruoyin Luo, Claire Scullin, James McElnay, Anita Hogg, 2012). All medicines for the patient were stored in the patient’s bedside medicine locker for the duration of the hospital stay. The percentage of wastage was high in this solution because usually the admitted patients were clinically unstable. Another example was reallocating extra employee. Reallocating additional staff to dispense coupled with unstructured efforts to improve matters (through increased hard work and diligence) had been marginally effective but difficult to sustain. In addition, it has an extra cost impact on the hospital budget.

Failure Mode and Effects Analysis method (FMEA) was an ongoing quality improvement process that is carried out in healthcare organisations by a multidisciplinary team used to look carefully and systematically for vulnerable areas in a process to determine points of potential failure and what their effect would be before any error happens (ISMP, 2005).

Afolabi et al. (2003) studied waiting time at many hospitals. The study used the workflow analysis method. They grouped workflow into two sub-components “process” and “delay”. A process component involved a staff member actively working on the prescription, while a “delay” component involved the prescription lying idle and waiting for a staff member to work on it. They found that most of the patient waiting time in the hospital can be accounted for by delay components of the dispensing procedure.

4.3.3 Method

Five multidisciplinary teams, representing the different involved departments at Heraa Hospital, were invited to meet and analyse the discharge process and to identify possible causes of failures as well as their potential effects for each step of discharge process. The teams are nursing, medical staff, pharmacy, logistic and porters' departments.

4.3.3.1 Design

Process and value mapping and failure mode effect analysis of current processes (FMEA).

4.3.3.2 Setting

Pharmacy department of Heraa Hospital.

4.3.3.3 Primary Outcome

To identify higher-priority potential failure modes and planning changes in clinical practice to facilitate patient discharge.

4.3.4 Result and Discussion

The multidisciplinary team held only three meeting[3]. The contributing factors that caused medicines dispensing delay for discharged patients were the time spent to prescribe, dispense and deliver these medicines to the patient. Figure 4-2 explains the workflow for discharged prescription and introduces the problems and suggested solutions. The current system was time consuming and inefficient. For instance, Heraa Hospital received feedback that a patient had waited 8 hours for pharmacy to dispense their prescription. Investigation showed that the patient was told at 8:30 am that they could go home at that day, and yet the prescription was not received by pharmacy until mid-afternoon. The prescription was processed by pharmacy within an hour and returned to the ward on the next routine run. Although the pharmacy had met its turnaround target, the patient's perception was that the prescription had been in the pharmacy since early morning and it had taken several hours to be dispensed.

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[3] This project has been stopped for unknown period, for this reason, the collected data was limited.

This perception had clearly impacted the patient's day of discharge experience and on the reputation of the pharmacy department.

Based on feedback from patients and continual observation, it was found that beyond the pharmacy the whole discharge process was the issue. An audit was carried out to follow the progress of discharge prescriptions and to ascertain how much of the discharge prescription journey was actually spent in pharmacy.

Figure 4-3 illustrated cause and effect diagram for delay dispensing discharge medications.

4.3.5 Key Finding of Dispensing Discharge Medications Study

1. Medication delivery time within 30 mins. The problem was typically not poor pharmacists performance but the shortage of delivery pharmacists. A suggested solution was providing ADS system in each ward. Employing more pharmacists was a temporary solution. However, this could create more chaos due to the small size of inpatient pharmacy comparing to the size of hospital.

2. The researcher noticed that the average pharmacy staff have short experience.

3. Presenting various programmes that raised the acceptance of technology awareness among the hospital staff.

Table 4-3 Dispensing Discharge Medications system study factors

Identified known factors		**New Findings from CRP system**
Technology	Vision	Implementation Plan & Unclear workflow
	Complexity	
Organisational		Awareness
Environmental	National healthcare system	
	HIT Investment	
Human	Experience	Shortage of professionals
	Age	

The factors from this case adds to the Initial Framework in Section 4.4.

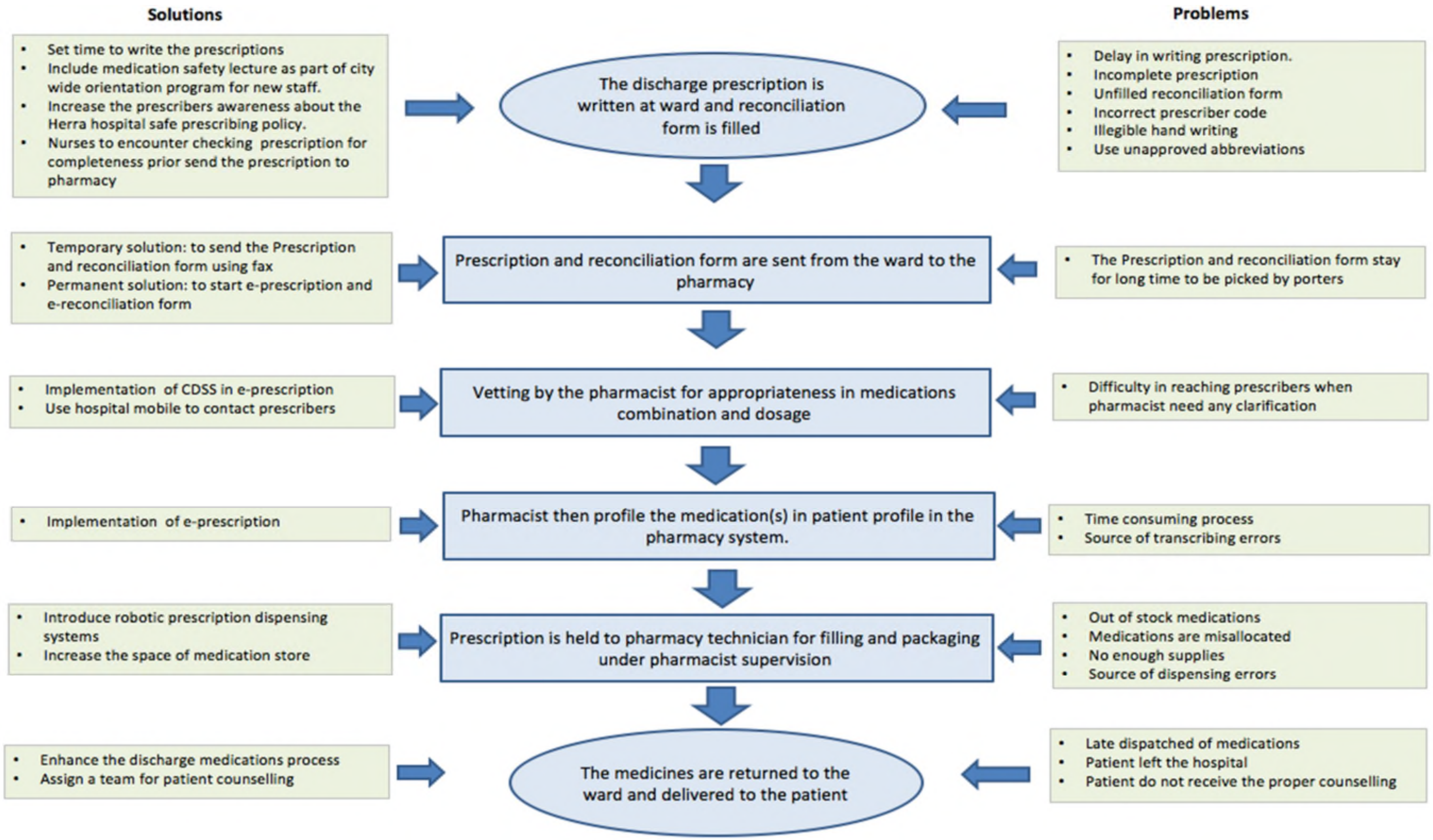


Figure 4-2 Workflow for discharged prescription and introduces the problems and suggested solutions

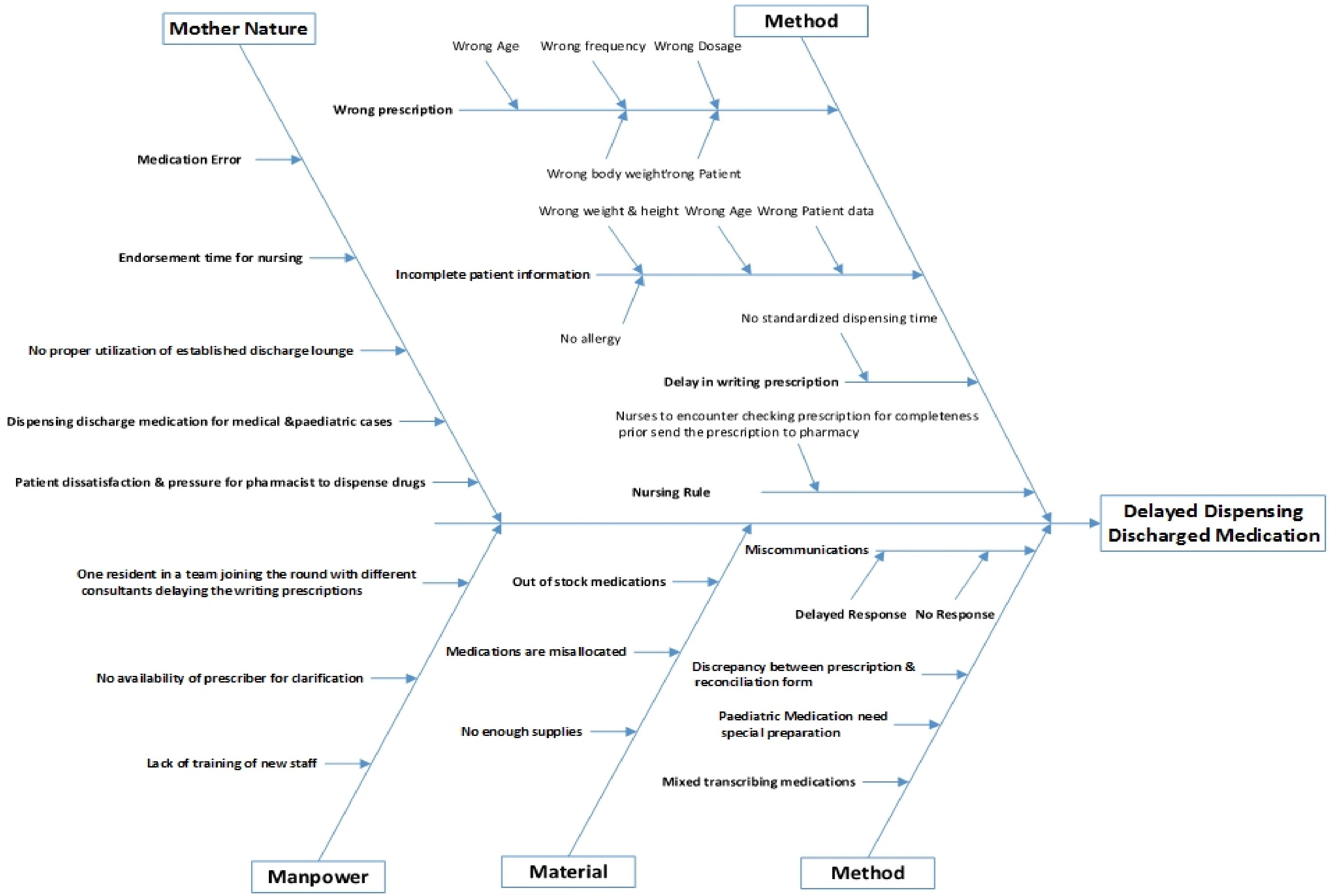


Figure 4-3 Cause and effect diagram for delay dispensing discharge medications

4.4 Initial Framework for HIT Adoption

This section represents the initial framework for Implementation Issues for HIT adoption. Figure 4-4 illustrates the framework with: the critical factors identified in the literature review stage (in grey); the factors defined at two initial study (in orange).

4.4.1 Technology Factors

The four main technology factors are: HIT strategy, IT infrastructure; Interoperability, Information and Data.

In the IT Infrastructure factor, old infrastructure was considered as a major problem that affects the nurses and pharmacists' acceptance. Despite the huge efforts and progress, hospitals management was still lacking essential components and they were far from satisfying the needs. For example, the PSMMC's main system was still using the mainframe which started operating in 1982.

The Interoperability factor addressed the significant mapping and integration since the hospital suffered from the failed automated medication dispensing system (ADS) project as explained in sections 4.2.3.1.

In the Information & Data factor, the issue of output quality and accuracy in nursing ward was considered as one of the obstacles. For example, when a nurse dispensed medication from the Pyxis machine, the chance of errors may affect the accuracy of inpatients medication. As a result, the low quality and accuracy of data created low trust of system information.

In the HIT Strategy factor, the Implementation Problem Plan was not getting a lot of attention from the Ministry of Health (MoH). However, solid plans for HIT was considered a critical factor in workflow development in any hospital.

4.4.2 Organisation Factors

The organisation context has three main factors. Organisation Culture formed with two factors identified in the literature: resistance to change and computer self-efficacy. Top management was previously identified with one factor: leadership support.

According to the research findings in this chapter, the sub-factors were selected. Computer self-efficacy was removed as the hospital staff were all computer confident. Awareness was added as raising the awareness about the necessity of HIT promoted better nurses HIT adoption.

4.4.3 Environment Factors

Environment context included the cultural factors that had great impact on HIT adoption among nurses. Vendor pressure received less attention by top leader at the hospital as well as on the nationality level. The shortage of qualified international company as system provider allowed some national providers to take advantage and offer low HIT standards.

4.4.1 Human Factors

The human context has two main factors: Human Capacity and System Used. The two sub-factors of human capacity in loss of productivity and shortage of professionals were two major obstacles facing Saudi healthcare organisations. For example, low enthusiasm was considered as a critical factor due to the lack of IT support, slow network, and consistent pressure by top management to use this unstable system during the implemented and trial period.

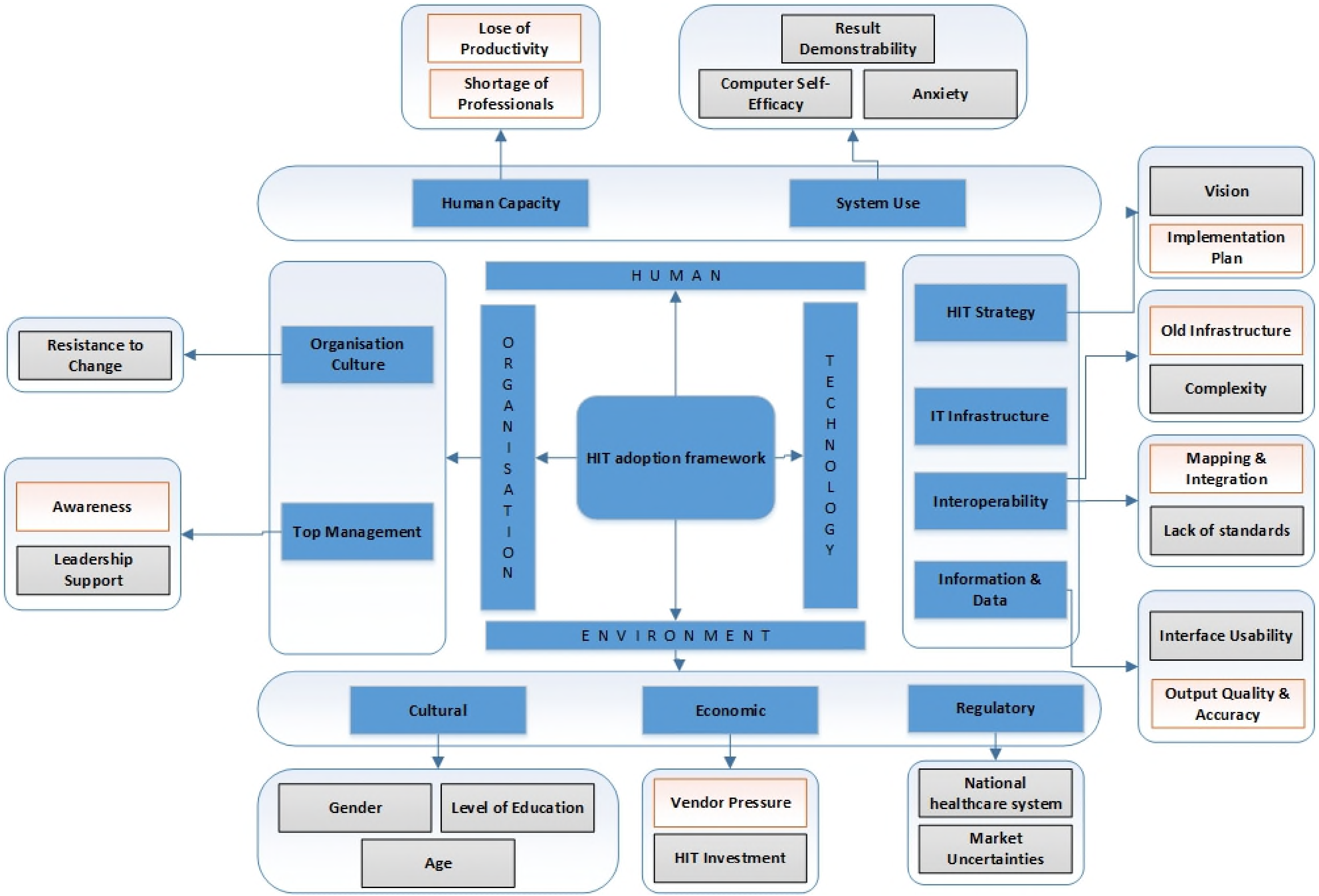


Figure 4-4 Initial Implementation Issues Framework for HIT adoption

5 Health Information Technology (HIT) Implementation (HIT Implementation Issues Framework Refinement and extending TAM3 model)

5.1 Introduction

This chapter presents two real life implementation case studies that were the quasi-experimentation approach to validate the Implementation Issues Framework in Figure 4-4. The two studies conducted in this chapters were the CPR system and the Nurtal/Pharmatal System.

The purpose of these studies are:

1. To understand deeply the critical factors for HIT adoption and the validate H-TOE picture.
2. To distinguish the differences and status of these critical factors, so that sub-factors can be categorised.
3. To extend the TAM3 model to identify and study the factors that influence the nursing acceptance of technology.

Each study is discussed with its purpose, methodology, results and finding. Finally, the framework and the developed model are presented at the end of this chapter.

5.2 CardioPulmonary Resuscitation (CPR) System

5.2.1 Purpose

The aim of this study was to present a computer based CardioPulmonary Resuscitation (CPR) calculator as a safer and faster method for CPR calculation than manual calculation. This project was to replace the existing paper based CPR card with a CPR calculator combined with Clinical Decision Support System (CDSS).

5.2.2 Materials and Methods

5.2.2.1 Study Setting

The study was conducted in the paediatric wards in the Prince Sultan Military Medical City (PSMMC). The pharmacy and nursing departments in PSMMC started a project to develop a CPR card software to calculate the CPR medication doses. The objectives of this project were to reduce the chance of medication errors and to reduce the time needed to prepare the CPR card.

As part of the admission procedure in PSMMC, CPR medications doses were calculated for each paediatric patient as illustrated in Figure 5-1. The card required 25 calculated data entries. The PSMMC CPR committee which consisted of a consultant clinical pharmacist, a consultant intensivist physician and a nurse was responsible for evaluation of all the original medications of CPR card including medications and doses. The doses were calculated based on the child weight. The CPR medications chart consisted of 14 medications, the Cardioversion procedure dose and the length of Endo Tracheal Tubes (ETT). The CPR medications chart was calculated manually by one nurse and the results were checked independently by other nurses then the card was approved by physician. Even the process was designed to be robust, it was still highly prone to errors. In addition, it was time consuming. In the Vardi et al. (2007) study, the doses were calculated by one nurse and another nurse and a physician would check the results independently. Thus any errors represented an error that evaded a triple check (by two nurses and a physician).

The PSMMC CPR card carried the names and doses/kg of the medications as well as the concentrations of CPR medications. Several factors made children in a critical care setting especially vulnerable to medication errors and adverse events, among them were weight-based dosing, significant weight changes over short periods of time, dilution of medications, and the decreased communication ability of paediatric patients and critically ill patients (Kaushal *et al.*, 2001; Fortescue *et al.*, 2003; Potts *et al.*, 2003). The calculated doses of CPR card were considered as ‘‘standing orders’’ or ‘‘orders on hold’’ for each patient admitted in paediatric wards, to be executed at the time of CPR without any additional checking.

A study conducted at King Saud Medical City (KSMMC) Riyadh, Saudi Arabia found that medication errors were less likely to be reported due to fear of punishment (Almutary and Lewis, 2012; Al-Zaagi *et al.*, 2015). Also, 90% of KSMMC nursing staff were foreigners and it might appear that they were less familiar with the process of reporting medication errors or were fearful (Al-Awa *et al.*, 2012). PSMMC adopted the blame free culture to encourage reporting of errors however; the number of reported errors was still very low. Therefore, the task group decided to develop this CPR calculator regardless of the number of reported medication errors. Also, the time needed for the completing and printing the CPR card was another main factor.

5.2.2.2 Patient Population

All admitted paediatric patients. The average daily number of admitted paediatric patients was 65 patients including emergency department.

5.2.2.3 Design

Experimental prospective cohort study.

5.2.2.4 Method

From 300 nurses working in PSMMC paediatric wards, a group of 70 nurses were randomly selected from all the paediatric wards including inpatient wards and emergency department, in the month of October 2016, to calculate a CPR card manually then to enter the patient data into the CPR calculator. The time used to complete the manual calculations of the paper based CPR card and the time used to finish entering patient information into the CPR calculator were recorded. In addition, the number of medication calculation errors were recorded. The research received the approval from the research ethic committee.

5.2.2.5 Data Analysis

Paired sample t-test was used to compare the time used to prepare the CPR card and the errors in the CPR card before and after the implementation of the CPR calculator. In addition, descriptive statistics were generated using Microsoft Excel 2013.

PAEDIATRIC CPR CARD

Name		Number		Weight	

DRUGS (IV Route)	Concentration	Dose/ kg	Dose ml/kg	Final Dose
Adrenaline 1:10,000	0.1 mg/ml	10mcg/kg	0.1ml x	= mls
Pulseless arrest after 1st dose of Adrenaline				
Adrenaline1:1,000	1mg/ml	100mcg/kg	0.1ml x	= mls Adre
Atropine	600mcg/ml	20mcg/kg	0.03 ml x	= mls Atro
Ca Cl3 10%	100mg/ml	20mg/kg	0.2 ml x	= mls CaCl3
NaHCO3 8.4%	1meq/ ml	1meq/kg	1 ml x	= mlsNaHCO3
Lignocaine 1%	10mg/ml	1mg/kg	0.1ml x	= mls Ligno
Narcan	0.4mg/ml	0.1mg/kg	0.25ml x	= mls Narcan

DRUGS (ET Route)	Concentration	Dose/kg	Dose ml/kg	Final Dose
Adrenaline 1: 1000	1mg/ml	100mcg/kg	0.1ml x	= mls Adre(ET) Dilute in 1-2 mls NaCl
Atropine	600mcg/ml	20mcg/kg	0.03ml x	= mls Atro(ET)
Lignocaine 1%	10mg/ml	1mg/kg	0.1ml x	= mls Ligno(ET) Dilute in 1-2ml NaCl
Narcan	0.4 mg/ml	0.1mg/kg	0.25 ml x	= mls Nar(ET)

DEFIBRILLATION	2 Joules/ kg	2 Joules x	= Joules

INTUBATION Drugs	Concentration	Dose/kg	Dose ml/kg	Final Dose
Morphine	10mg/ ml	0.1mg/ kg	0.01 ml x	= mls MSO4
Suxamethonium	50mg/ml	1mg/kg	0.02ml x	= mls SUX
Atropine	500mcg/ml	10mcg/kg	0.02ml x	= mls Atro
Give; if 2nd dose of Suxamethonium is needed				

ETT size:		Cut at: cm	Trach size:	
Suction Catheter size :		At: cm		

Signed by:_______________ and ______________________ DATE ____________________

Figure 5-1 Old CPR form which used to be filed manually

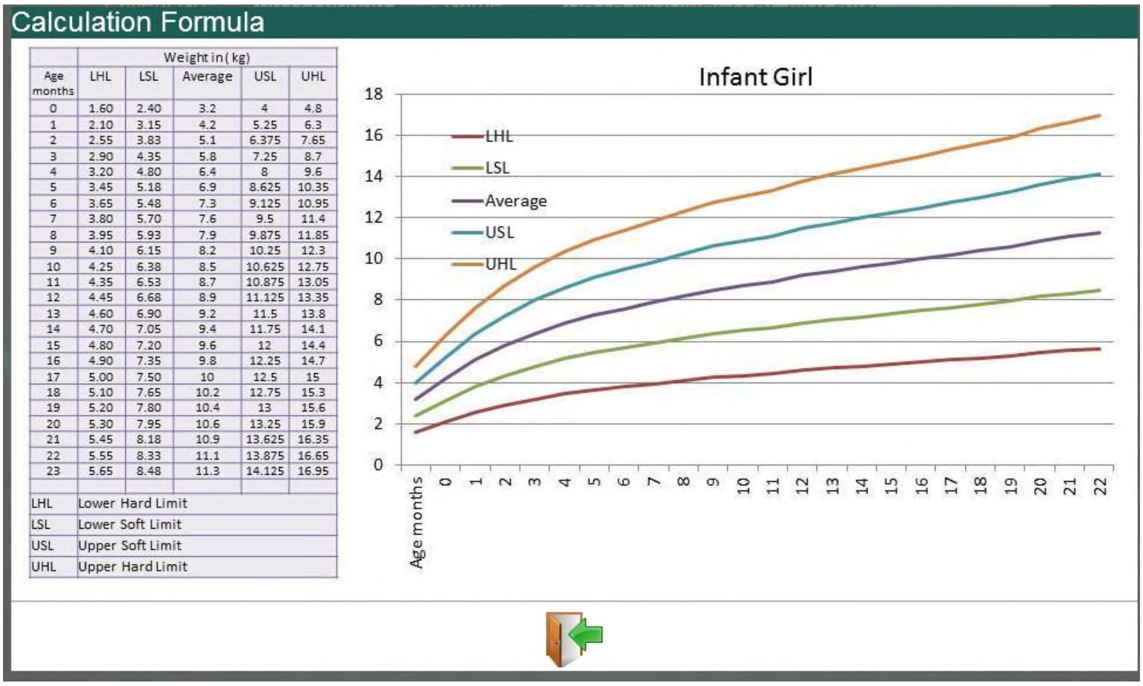
5.2.3 Computer Systems

The CPOE/CDSS was developed in two stages: Microsoft Excel spreadsheet and web based computer programs using a mixture of the HTML and the .NET Framework.

The first stage in calculator development was creating a Microsoft Excel spreadsheet to be used as prototypes for the dose calculations. It calculated the 14 medication doses, the Cardioversion procedure doses and the length of ETT. The implementation of the developed spreadsheet aimed to test the concept and process as well as to measure the success of the proposed solution. In addition, it was used as a temporary solution until the calculator was completed. The Excel spreadsheet was deployed in the paediatric section at the emergency department. The first version of the Excel spreadsheet was installed on a personal computer for one month and it experienced many changes based on the feedback of users. Once the nurse entered the patient's weight, calculations were instantly performed and the results displayed. A paper copy could be printed out immediately, with all the drug doses for reference. As with all such calculators it was vital that the accuracy of weight entry was double checked by a second person before medication was administered.

The CPR medication doses were fixed according to the patient's weight. However, there was a potential of entering a wrong patient's weight. For that reason, a software that linked an average patient's weight based on The World Health Organization (WHO) (Health, 2009) child growth chart with the patient's age using soft and hard limits for weight was used to minimise potential errors. A team from pharmacy and nursing developed the upper and lower limits of weight based on the patient's age and gender. An example of these tables is shown in Figure 5-2. The soft limit would alert the user that he/she exceeded the usual weight for this patient based on the tables and gave the user the chance to override the alert. While the hard limit would stop and prevent the user from continuing the process once he/she exceeds the hard limit as shown in Figure 5-3. These improvements were implemented in the second stage.

In the second stage, the CPR calculator was developed on web based computer programs using a mixture of the HTML and .NET. The calculator was uploaded to the hospital intranet and was initially used in one ward before being rolled out to the rest of the hospital. The CPR calculator was designed to offer a simple user-friendly web-based interface. The CPR calculator was integrated with the hospital information systems. After entering the patient medical record number the CPR calculator would retrieve the patient age and gender. These information were used to validate the patient's weight using the aforementioned tables.



Age months	LHL	LSL	Average	USL	UHL
	Weight in (kg)				
0	1.60	2.40	3.2	4	4.8
1	2.10	3.15	4.2	5.25	6.3
2	2.55	3.83	5.1	6.375	7.65
3	2.90	4.35	5.8	7.25	8.7
4	3.20	4.80	6.4	8	9.6
5	3.45	5.18	6.9	8.625	10.35
6	3.65	5.48	7.3	9.125	10.95
7	3.80	5.70	7.6	9.5	11.4
8	3.95	5.93	7.9	9.875	11.85
9	4.10	6.15	8.2	10.25	12.3
10	4.25	6.38	8.5	10.625	12.75
11	4.35	6.53	8.7	10.875	13.05
12	4.45	6.68	8.9	11.125	13.35
13	4.60	6.90	9.2	11.5	13.8
14	4.70	7.05	9.4	11.75	14.1
15	4.80	7.20	9.6	12	14.4
16	4.90	7.35	9.8	12.25	14.7
17	5.00	7.50	10	12.5	15
18	5.10	7.65	10.2	12.75	15.3
19	5.20	7.80	10.4	13	15.6
20	5.30	7.95	10.6	13.25	15.9
21	5.45	8.18	10.9	13.625	16.35
22	5.55	8.33	11.1	13.875	16.65
23	5.65	8.48	11.3	14.125	16.95

LHL	Lower Hard Limit
LSL	Lower Soft Limit
USL	Upper Soft Limit
UHL	Upper Hard Limit

Figure 5-2 Table of weight and weight validation female less than 24 month

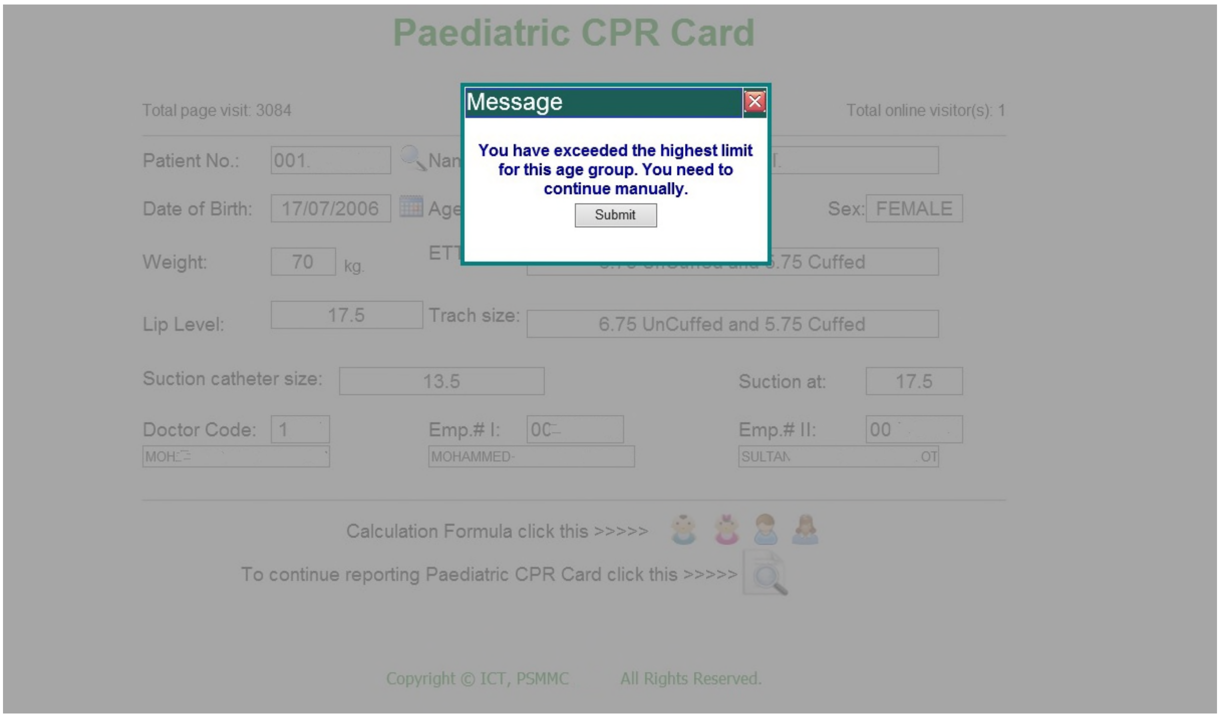


Figure 5-3 Hard upper limit message

5.2.4 Review Process

The task group from pharmacists and nurses examined the accuracy of calculations and formulas before and after implementation.

5.2.5 Results and Discussion

The study result showed that, using manual calculation, the average time for nurses to complete the calculations was 06:01. The longest time was 11:41 minutes and shortest time was 02:55 minutes. The average time needed to check the CPR calculation was 02:31 minutes. The maximum time was 10:55 minutes and minimum was 00:45 minute. The average total time to calculate and check the CPR card was 08:31 minutes. The longest time was 18:01 minutes and shortest time was 05:02 minutes. With the CPR calculator, the time needed to enter patient's medical number and patient's weight was 01:15 minute whereas the shortest time was 00:35 minute and longest time was 04:58 minutes. Table 5-1 summarised the study result. The reduction in the time needed for the preparation of the CPR card was dramatic and compared favourably with previous reports (Shannon *et al.*, 2002; Reed and Fothergill, 2007; Vardi *et al.*, 2007). Vardi et al., (2007) found the time to complete the CPR card dropped from 14:42 minutes to 2:14 minutes (Vardi *et al.*, 2007). Another study showed a significant time reduction, from 16:47 (range 09:40 to 25:30, standard deviation 04:43) with manual method and the mean time for the computer model was 05:12, (range 03:40 to 08:45, standard deviation 01:43) (Shannon *et al.*, 2002). The difference between time needed to complete CPR card manually and time needed to generate the CPR card electronically is statistically significant ($p < 0.05$).

One study showed that, all except one subjects (20) encounter at least one calculation error (Shannon *et al.*, 2002). Vardi et al. (2007) study used the reported incidents to measure the incident of errors. There were three reported incidents of errors among 13,124 CPR medications prescriptions during the year prior to the implementation of system and no report after the implementation of system.

In this study, using the manual CPR card, 23 nurses made errors out of the 70 nurses. A total of 101 errors were recorded from these 23 nurses. The nurse with the maximum number of errors made 17 errors on her form. She used mental calculation without any other aids. With the CPR calculator system, no errors are recorded. In this study, the errors can be classified into overdose and underdose. The causes of these errors are wrong calculations, illegal hand writing and decimal errors where the calculations were almost correct except the location of decimal was misplaced as shown in Table 5-2. There were no events of errors that could be attributed to the use of the CPR calculator in the PSMMC paediatric wards.

Garg et al. (2005) conducted a systematic literature review of 100 studies to examine the impact of CDSS on practitioner performance. They concluded that CDSS enhanced healthcare performance in 64% of the literatures and enhanced patient outcomes in 13% of the literatures. A systematic literature review by Kawamoto et al. (2005) of 70 studies concluded that CDSS significantly improved clinical practice in 68% of trials. CDSS minimises practice variation and enhances patient care. In addition, it make the calculation more accurate and faster (Shannon *et al.*, 2002). Many studies have shown that CDSS can improve physician compliance with hospital policies and reduce cost, and provide better patient care (Mawer, 1976; NEU *et al.*, 1982; Lesar *et al.*, 1990; Proost and Meijer, 1992; Lesar, Briceland and Stein, 1997; ‘Prevention of Medication Errors in the Pediatric Inpatient Setting’, 2003).

Benefits of the use of CPOE included the elimination of calculation errors and of illegible or incomplete orders, while CDSS helped in checking for patient factors (age, weight, allergies, renal function) and drug factors (dose, frequency, route). CPOE has been recommended as a tool that may prevent prescribing errors by the Institute of Medicine (IOM), American Medical Association, the American Academy of Paediatrics, ISMP, Leapfrog Group, and others (*To Err Is Human*, 2000, ‘Prevention of Medication Errors in the Pediatric Inpatient Setting’, 2003; Fortescue *et al.*, 2003).

The CPR calculator had been proposed as a tool that could prevent errors that occur during the medication calculation process, and its use was suggested as a hospital safety standard that results in improved quality of care and reduced health care costs.

Table 5-1 Summary of experiment results

	Calculation	Check	Total Time	Profiling	Manual errors
Total	07:00:36	02:55:43	09:56:19	01:27:48	101
Mean	00:06:01	00:02:31	00:08:31	00:01:15	1.44
Max	00:11:41	00:10:55	00:18:01	00:04:58	17.00
Min	00:02:55	00:00:45	00:05:02	00:00:35	0.00

Table 5-2 Calcifications and causes of errors

Cause	Overdose errors	Underdose errors	Total
Wrong calculation	53	40	93
Decimal	2	3	5
Illegible hand writing	2	1	3
Total	57	44	101

5.2.6 Legends of Tables and Figures

Appendix B presents the rest of tables and figures for the CPR system implementation.

5.2.7 Key Findings of CPR Study

1. This study had found that nurses are unaware of some features of the system.
2. There was a need for more one to one training, due to some nurses having low computer skills. However, the majority of nurses found the CPR system easy to learn and understood the natural and complexity of the system.
3. The nurses during the experiment sometimes made potentially fatal medication calculation mistakes. The CPR form was revised and the result reviewed with nurses. With automation, it was noticed that they sometimes did not feel their sense of responsibility for mistakes.
4. Show feedback response, for example**,** after being able to access the system live on intranet, the background of the main screen interface was in dull black colour. Many nurses gave feedback to the IT department to change the colour to white or other colour to make display more visible and easier to read.

Table 5-3 CPR system study factors

Identified known factors		New Findings from CRP system
Technology	Interface Usability	IT Support and Maintenance
	Complexity	Output Quality & Accuracy
Organisational	Leadership Support	Sense of Responsibility
		User Involvement and Participation
Environmental	Experience	Blaming Culture
Human	Result Demonstrability	User Enjoyment
		User Training
		Blaming Culture

These factors contributed to Section 5.4.

5.3 Nurtal/Pharmatal System

5.3.1 Purpose

In Prince Sultan Military Medical City (PSMMC), communication between the nursing staff and the pharmacy relied primarily on telephone calls. The pharmacy administration had received many complaints about unattended calls, and investigations revealed an enormous volume of calls. As a result, many pharmacists were unable to answer telephone calls.

The aim of this study was to develop solutions to reduce the volume of telephone calls to reduce workload for pharmacy and nursing staff.

5.3.2 Materials and Methods

5.3.2.1 Design

A quasi-experiment with pre-post testing.

5.3.2.2 Method

The improvement project adopted a six-step continuous improvement approach. The first step consisted of problem analysis, including data collection and analysis data. A new form was designed to measure and classify the incoming calls. The second step consisted of the proposed solution. The third step was developing a new working process supported by paper forms to ensure that a good method of working was designed. These forms assisted in the understanding of the project requirements as well as being the first phase of the IT system development. The fourth step consisted of creating IT systems to support the pharmacy and the nursing team to assess the technology. The fifth step was the integration of the pharmacy and nursing systems to automate the improved work process. The sixth step consisted of the ongoing continuous improvement and enhancement of the integrated systems. Figure 5-4 illustrates these six steps.

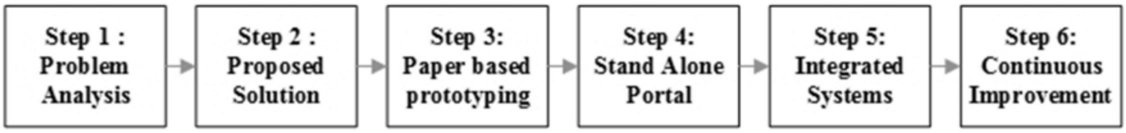


Figure 5-4 Project steps

5.3.2.3 Data Collection

Systematic analysis of the telephone call communication problem was the foundation of the improvement project. A survey was conducted in PSMMC to measure the volume and type of telephone calls to manage this problem and reduce its impact on the pharmacy and nursing staff. A data collection form was developed. The telecommunication department provided the details of incoming and outgoing calls for the pharmacy extensions. Collected data were classified according to telephone call types. Based on the high volume of calls requiring follow-ups, a communication tracking system was designed and created by the IT department to enhance communication between the pharmacy and nursing departments and reduce the interruptions for both parties. The IT development was divided into three phases and is described in the results section. After the system was implemented, the results were evaluated using a review survey to measure changes in the number and types of calls.

5.3.2.4 Data Analysis

Descriptive statistics were generated using Microsoft Excel 2007. T-test was used to measure the differences prior and post implementation.

5.3.3 Results and Discussion

5.3.3.1 Problem Analysis

Telephone call data were obtained from the telecommunication department from 09/02/2015 to 23/02/2015. The data indicated that 3,328 calls were received by the inpatient pharmacy and 1,138 calls were made, with a total of

4,466 calls. The peak time for receiving calls was between 2:30 pm to 5:00 pm on Monday and Tuesday. The average duration was 00:01:12, which was shorter than the average duration reported in the McCluskey study, which was 3 minutes (McCluskey, 2012). The total duration was 17:00:21 hours during the 2 weeks of monitoring.

To distinguish the types of received calls, a sample of 296 calls was analysed according to type. The types of calls were categorised as confirmation of receiving the prescription, follow-up, IV discontinuations, missing dose, as needed medications, professional inquiries and other. The number of calls according to their category are presented in Table 5-4. Nurses commonly considered pharmacists as a resource regarding the therapeutic and adverse effects of medications, and as result, the pharmacy received many calls to clarify issues related to medication administration, including illuminating unusual medications, how to make up IV medications, the appropriateness of an unclear medication prescription, the method of administering an unfamiliar dose, crushing particular tablets and the organisation of discharge medications. Frequently, these conversations led to better patient care (Manias, Aitken and Dunning, 2005).

The most common type of phone call was follow-up, with 112 calls. This result suggested that the pharmacy lack an efficient system of prescription tracking and that the nurses could not track the status of their patients' medication prescriptions. The time spent tracking the status of medication prescriptions could be more efficiently used by both the pharmacy staff and nursing staff. In addition, efficiency could also be improved by reducing the number of telephone calls. Sørensen and Brahe (2014) classified the interruption into acceptable or unacceptable, such as when a colleague enquired for information that is readily available in the patient's records. Nevertheless, interruptions could be considered avoidable or unavoidable.

Table 5-4 Analysis of the types of telephone calls received from the nursing staff in PSMMC prior and after the implementation project

	Duration		
	Before	After	P value
Average (HH:MM:SS)	00:01:12	00:01:43	> 0.001
Mode (HH:MM:SS)	00:00:21	00:00:56	
Standard Deviation (HH:MM:SS)	00:01:10	00:01:36	
Minimum (HH:MM:SS)	00:00:00	00:00:00	
Maximum (HH:MM:SS)	00:22:25	00:26:27	
Sum (HH:MM:SS)	17:00:21	04:42:30	> 0.001
Count (Calls)	4,465	2,630	> 0.001

5.3.3.2 Proposed Solution

Many studies had confirmed the benefits of computerised prescriber order entry (COPE) for minimising medication errors and enhancing communication among healthcare professionals (Bates *et al.*, 1998; Evans *et al.*, 1998; Doolan and Bates, 2002). PSMMC was planning to implement a new health information system (HIS) which includes a COPE. However, this was a long-term project, and the specified HIS did not include a communication and prescription tracking system. Thus, an IT development project was initiated to address the immediate necessity for a pharmacy-nursing bidirectional communication system. The proposed system sends prescriptions, provides online status for prescription progress and documents any communication between the pharmacy and nursing staff. Lochbihler (2011) concluded that by implementing dose-tracking technology in the Cleveland Clinic, they increased the efficiency of the drug distribution process. Furthermore, real-time tracking capabilities speed up and ease the identification of medication locations, and their reporting system helped improve the drug distribution process and ensured that doses were delivered in a timely manner. In a similar approach at the Auckland District Health Board, the inpatient pharmacy planned to implement a tracking system for prescriptions during the dispensing process to control the number of interruptions. The aim of this system was to provide the status of a prescription at any point during the dispensing process (Subramoney, 2009).

Andersen examined important barriers to implementing drug-prescribing sheets for recording both drug prescriptions and drug administration, as experienced by nurses and physicians. The author identified organisational difficulties faced by healthcare professionals when using drug-prescribing sheets for recording both drug prescriptions and drug administration. These difficulties could be summarised as a lack of knowledge of procedures, inadequate dissemination of knowledge, and poor cooperation and scepticism among those who put drug handling into practice, which were expected to have an impact on the quality of health care (Andersen, 2002).

IT solutions could significantly enhance teamwork among clinical professionals by improving information transfer, workflow, and communication, resulting in marked improvements in patient safety and overall the quality of care (Doolan and Bates, 2002; Meadows and Chaiken, 2003; O'Daniel and Rosenstein, 2008). Furthermore, Poon *et al.*, (2006) concluded that the implementation of bar code technology decreased the medication errors in healthcare. Moreover, in industries outside the healthcare, barcode technology eased and accelerated the transactions of these industries.

5.3.3.3 Paper-based Prototyping

The third step in system development was developing paper-based communication forms to be used as prototypes for the communication and tracking program, as well as to be used as a temporary solution until the program implementation was completed, as shown in Figure 5-5. The paper-based communication forms underwent many changes based on the feedback of nurses and pharmacists.

Prince Sultan Military Medical City
Department Of Pharmaceutical Services
UNIT DOSE – NURSING / PHARMACY COMMUNICATION FORM

To Pharmacy____________________ Patient Name ________________________
Ward ____________________ Patient # ________________________
Bed ________________________

Missing Dose

NAME & STRENGTH	

Omitted dose

NAME & STRENGTH	
REASON	

Refill Dose (PRN and Bulk items e.g. ointment, eye drops, etc)

NAME & STRENGTH	

Patient Transferred

Emergency department	WARD/ UNIT	OTHERS (SPECIFY)

New Admission : patient information entered/ updated into the computer ☐
please attache the reconciliation form

Others____

Nurse name:____________________________
(Print legibly)
Signature :____________________________
Date :__________ Time:__________
Extension:____________

For Pharmacy Use:
Pharmacist:____________________________
Date:____________ Time: ________

Please supply the following medications
Circle item(s) required: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Circle action required: STAT ASAP Routine to be included in MAR only

New order Renew Modify dose/ frequency Discontinued Hold Resume

Comments:

N= New order R=Renew M= Modify dose/ frequency D= Discontinued H= Hold RE= Resume

This Form is not applied for Narcotic Medications.

Figure 5-5 Nursing pharmacy communication form

5.3.3.4 Stand-alone Portals

The IT department developed computer-based systems to automate the paper forms, initially as two stand-alone systems accessed through web portals: one for the pharmacy (Pharmatal) and one for the nurses (Nurtal). The program was piloted in one ward before being rolled out to the rest of the hospital. This step had a minimal impact on the volume of telephone calls.

5.3.3.5 Integrated Systems

The pharmacy received many types of prescriptions, such as (STAT) from the latin word statim, which means "instantly" or "immediately", as soon as possible (ASAP) and routine prescriptions. STAT prescriptions were prescriptions that are lifesaving and require immediate processing; any delay may expose the patient to a risk of death. ASAP prescriptions were prescriptions for medications that need to improve patient comfort, such as painkillers. Routine prescriptions were prescriptions that does not meet the previous definitions. The integrated system provided the platform for managed communication between the pharmacy and nurses. The pharmacist screen listed the patient sorted according to their priority colour coding, red for STAT and yellow for ASAP medications, provided the capability to track all urgent prescriptions. The system included the patient information screen, which allowed the pharmacist to access to the patient's laboratory results, attributes, allergies, drug profiles, previous discharge summaries and inpatient requests. In addition, a dashboard where the inpatient requests were listed and the image of the scanned prescription was displayed, with the capability of enlarging the scanned prescription.

The pharmacy nursing communication form was transferred into an electronic form. This screen was used to send the communication from the pharmacy to the nursing station. In the nursing interfacing screen Nurtal, Figure 5-6, the nurse could select the scanned prescription and indicate the urgency of the prescription and added nurse comments. Nurtal had a dashboard to list all pharmacy requests. If the nurse needed to know the status of the request, the nurse could click on the request, and then a pop-up screen would show the request status.

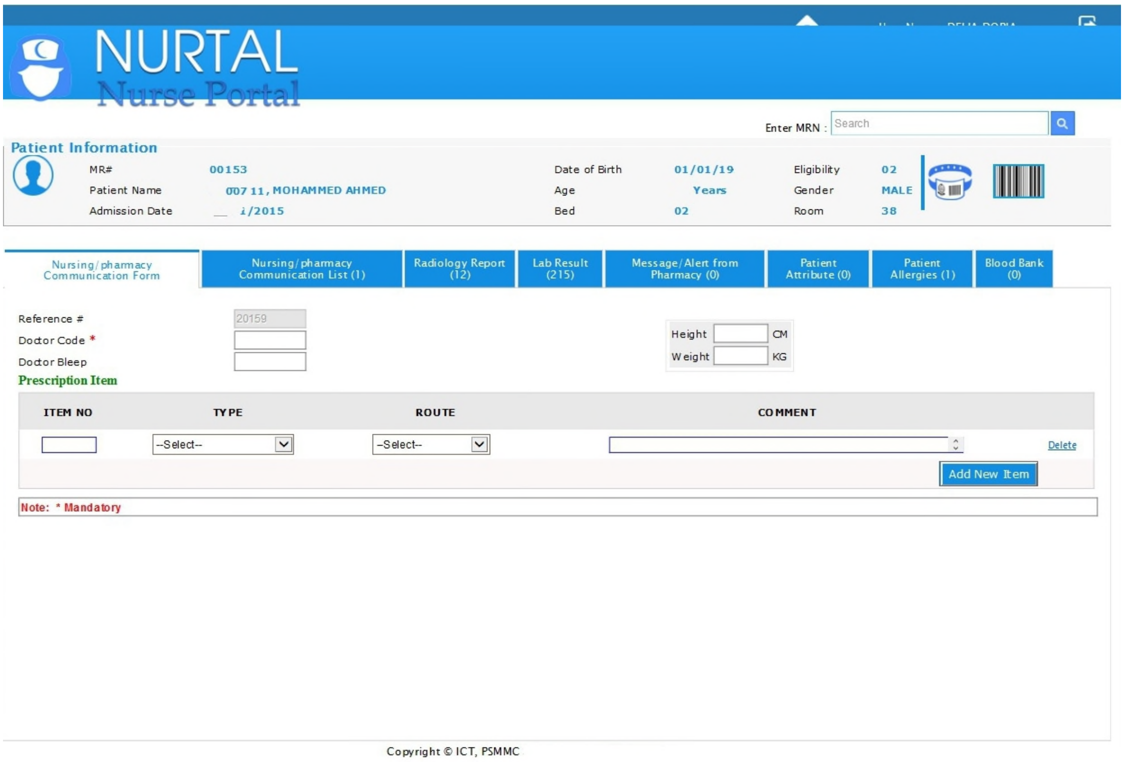


Figure 5-6 Nursing pharmacy communication screen where the nurse selects the urgency, route and writes comments

- **Post-implementation Analysis**

After the roll out of the integrated system, the telecommunication department provided data for telephone calls from 05/10/2015 to 20/10/2015. The results revealed a significant reduction (p> 0.001) in the received calls from 3,328 to 1,796 calls. The outgoing calls decreased from 1,138 to 834 calls, with a total of 2,630 calls. The receiving call peak time did not change and remained between 2:30 pm to 5:00 pm. This might be explained by the nursing shift change at 3:00 pm on Monday and Tuesday. The average duration of calls increased significantly (p > 0.001) from 00:01:12 to 00:01:43, and this might be due to the change in the more professional nature of the inquiries.

To measure the impact of the system on the types of received calls, a sample of 300 calls was analysed according to type. The proportion of professional inquiries was increased due to the reduction of other types of calls. The total duration was 04:42:30 hours is a total call reduction. The proportion of confirmation calls, follow-up calls, calls to request supplies for missing doses and to inform about IV discontinuations decreased. All changes in the types of calls were significant except for the change in the calls to request supply for missing doses that was not significant with (p<0.2). The system reduced the necessity to call the pharmacy for regular cases.

5.3.3.6 Continuous Improvement

During implementation, the project encountered situations that needed enhancements. For example, upon patient arrival to the nurse station, the nurse printed the patient identification label, which includes a barcode, and this label is attached to the prescription. However, the Nurtal system has its own barcode. Thus, integration of the two barcode systems was a solution requirement. There were also occasional system/connection failures, leading to missed communications. A further compatibility problem was the Zero client computers used in many hospital locations, which were not compatible with the Zebra printers needed. Finally, the system response might be slowed because of congestion in the hospital network infrastructure, and the prolonged technical response time may compromise patient care. To solve these issues, the task group meets weekly to direct improvements.

5.3.4 Legends of Tables and Figures

Appendix C has the rest of tables and figures for the Nurtal system implementation.

5.3.5 Key Findings of Nurtal Study

1. This study has found that resistant to change is higher among pharmacists than nurses, due to the shortage of pharmacist staff. By observation, during the implementation phase a high number of pharmacists complained about the new system without any clear reasons or senseless excuses.
2. Due to hardware failure Zebra Printer (printer of patient identification label) or Incompatibility between Zero Client Computer and Zebra Printer, there were situations of label stickers shortage. System/Connection failure led to not all communications received. These problems created a new kind of resistant to change or low enthusiasm to use the system among pharmacist and nurses.

3. Lack of communication between IT department and nurses. The IT team eliminated some important features without any consultation or notification to nurses. Nurses were expecting some features to be restored, e.g. laboratory results could be available to access and print.
4. During the implementation, some nurses found the interface design too complex. The response and feedback from IT team was slow. It took more than 4 months to respond to these comments.
5. The loss of qualified pharmacists staff and their transfer to private sector.
6. Insufficient commitment of the top managers especially charge nurses (wards head).
7. The technical service venders not considered the nurses feedback about the proposed system and involved the related staff in decision making.

Table 5-5 Nurtal system study factors

Identified known factors		New Findings from Nurtal System
Technology	Mapping and Integration	User Involvement and Participation
	Interface Usability	IT Support and Maintenance
Organisational	Resistance to Change	Unprofessional Behaviour
Environmental	Image	Sense of Responsibility
	Leadership Support	Low enthusiasm
		Tribal Impact
Human	Age	User Training
	Level of Education	Work overload
	Nationality	

These factors contributed to Section 5.4.

5.4 Refined Framework for HIT adoption

This section represents the second and final revision of the proposed framework for HIT implementation in Saudi context. Figure 5-7 illustrates the framework: the critical factors identified in the literature review stage (in Grey); the factors defined at the initial study stage (in Orange); and finally, the factors found at the HIT Implementation case studies stage (in Green).

5.4.1 Technology Factors

The PSMMC IT department made outstanding progress especially through developing in-house software (Nurtal/Pharmatal system and CPR system) that was discussed previously in Chapter 5. Yet, the analysis of data showed an additional factor “IT Support and Maintenance” that need the focus of the IT team and hospital top leader.

5.4.2 Organisation Factor

Two factors were added to the organisation culture: 1) low enthusiasm 2) user involvement. More interesting, morality was added with two sub factors: 1) unprofessional behaviour 2) sense of responsibility. These new factors were of great importance in developing organisations performance.

5.4.3 Environment Factors

The analysis indicated that the environment factors had high impact on an organisation’s initiatives. In fact, in the “environmental” factor, culture had three added effective sub-factors of the organisation initiatives: 1) tribal impact 2) nationality 3) blaming culture.

5.4.4 Human Factors

This context had also received a lot of consideration, the analysis has added one factor to the system using: user enjoyment. The importance of human capacity has added two factors: 1) user training and 2) work overload.

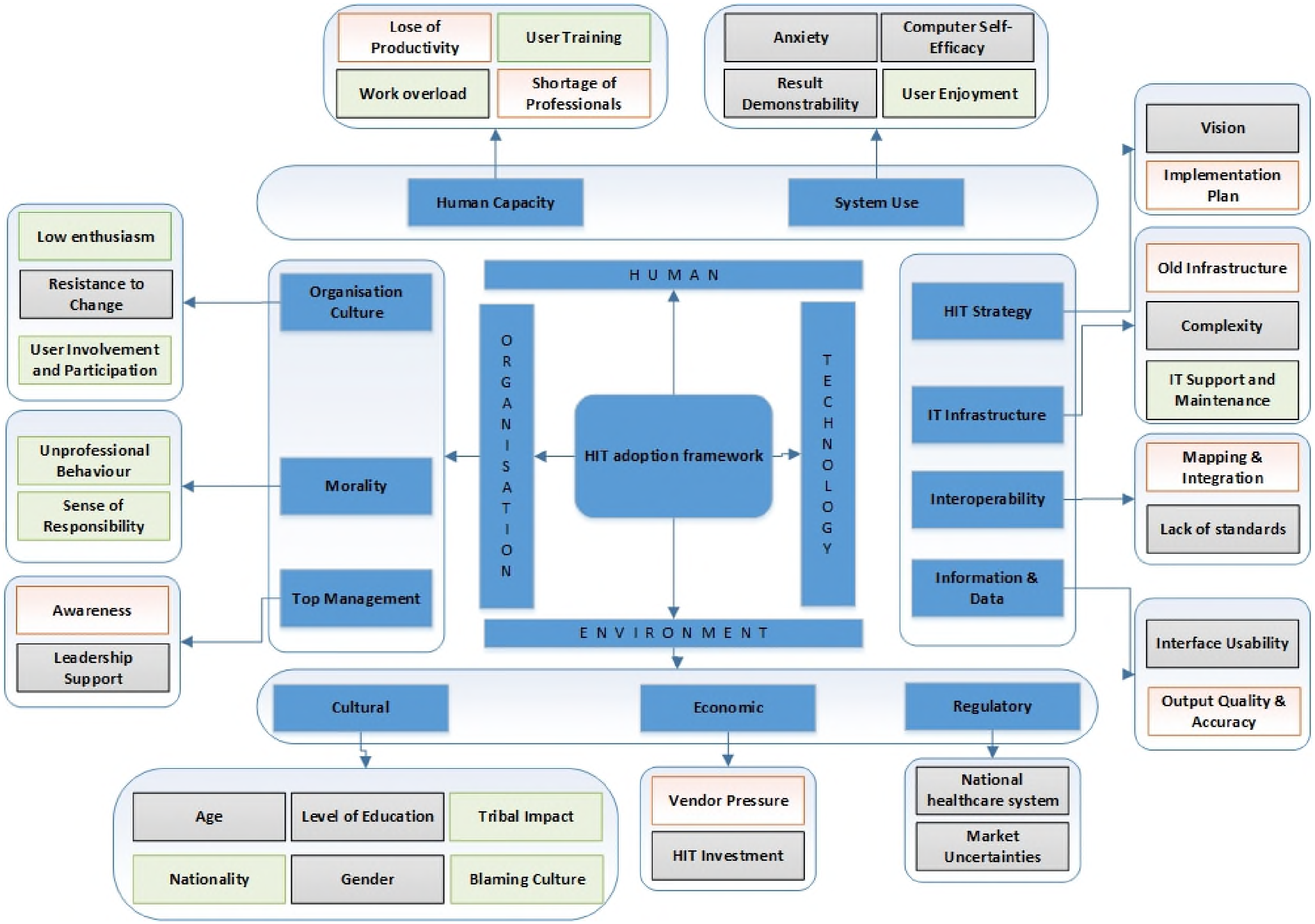


Figure 5-7 Final Implementation Issues Framework for HIT adoption

5.5 Extended TAM3 Model and Research Hypotheses

The factors in the Implementation Issues Framework was mapped using TAM3 to study their inter-relationships. TAM was chosen because it is the closest theory to H-TOE and can be easily mapped. The more comprehensive TAM3 (latest version) was used to cover the range of factors. The researcher took into consideration the role and level of the end users represented by the nurses. Some factors were mapped directly to TAM3 model without any changes (11 out 34) such as “User Employment” and “User Enjoyment”. Those factors that have similar meaning to TAM3 construct (5 out 34) were used as in the original TAM3 construct, e.g. “Loss of Productivity” that have similar meaning to “Job Relevance”. The original TAM3 construct was used before creating any new ones. In the end, only two new constructs were created: “User Training” and “User Involvement” (2 out 34).

It was not possible to use all these factors due to several reasons. H-TOE contains 34 factors which is too many for a single questionnaire. Therefore, some of the factors were not included (6 out 34). Furthermore, TAM3 model did not include any organisational level sub-factors targeted to the decisions makers in the hospital, and H-TOE factors like “Market Uncertainties” were out of the scope of this research. Finally, there were some factors that concern sensitive topics like morality (4 out 34). These missed out factors would be considered in future work.

The extended factors of TAM3 model as proposed is illustrated in Figure 5-8

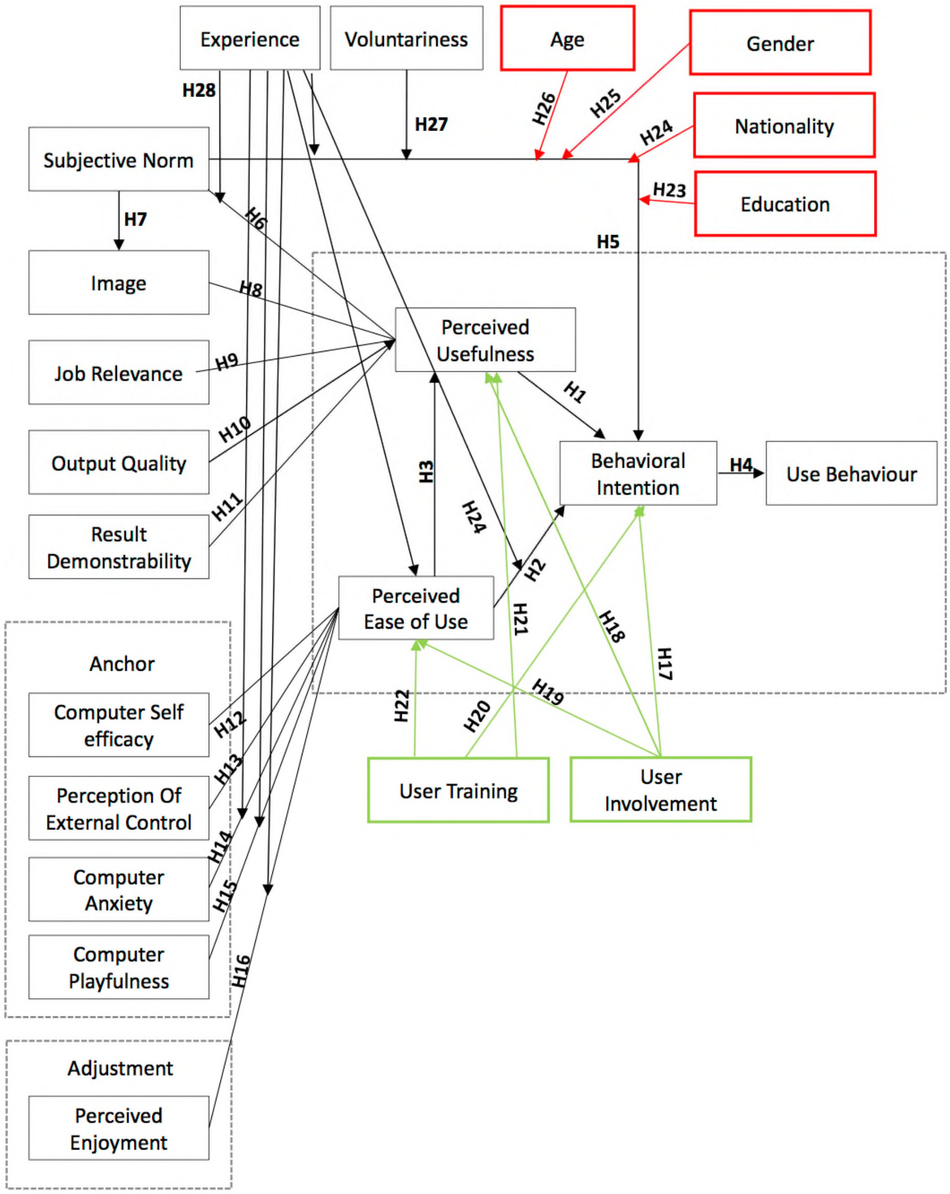


Figure 5-8 Extended of TAM3 model

In this study, 28 main hypotheses were defined to describe a total of 22 direct relationships to be tested for a positive influence on HIS success. The research aims to test the following:

- **H1**: Perceived usefulness has positively positive influence on behavioural intention to use HIT.
- **H2**: Perceived ease of use has positively influence on behavioural intention to use HIT.

- **H3**: Perceived ease of use has positively influence on perceived usefulness of HIT.
- **H4**: Behavioural intention has positively effect on usage behaviour toward HIT.
- **H5**: Subjective norm has positive direct effect on behavioural intention to use HIT.
- **H6**: Subjective norm has positive direct effect on usefulness of HIT.
- **H7**: Subjective norm has positive direct effect on image for using HIT.
- **H8**: Image has a positive influence on perceived usefulness of HIT.
- **H9**: Job relevance of HIT has positive influence on users‟ perceived usefulness of HIT.
- **H10**: Output quality has a positive influence on perceived usefulness of HIT.
- **H11**: Result demonstrability of HIT has positive influence on users‟ perceived usefulness of HIT.
- **H12**: Computer self-efficiency has positively related to perceived ease of use of HIT.
- **H13**: Perceptions of external control has significantly and positively effect to perceived ease of use of HIT.
- **H14**: Computer anxiety has significantly and negatively related to perceived ease of use of HIT.
- **H15**: Computer playfulness has a positive effect on perceived ease of use of HIT.
- **H16**: Perceived enjoyment has a significant positive effect on perceived ease of use of HIT.
- **H17**: User Involvement has a significant positive effect on behavioural intention of HIT.
- **H18**: User Involvement has a significant positive effect on perceived usefulness of HIT.
- **H19**: User Involvement has a significant positive effect on perceived ease of use of HIT.

- **H20**: Training has significantly and positively related to behavioural intention of HIT.
- **H21**: Training has significantly and positively related to perceived usefulness of HIT.
- **H22**: Training has significantly and positively related to perceived ease of use of HIT.
- **H23**: The moderator (education) will significantly influence the relationship between subjective norms and behavioural intention to use HIT.
- **H24**: The moderator (nationality) will significantly influence the relationship between subjective norms and behavioural intention to use HIT.
- **H25**: The moderator (gender) will significantly influence the relationship between subjective norms and behavioural intention to use HIT.
- **H26**: The moderator (age) will significantly influence the relationship between subjective norms and behavioural intention to use HIT
- **H27**: The moderator (voluntariness) will significantly influence the relationship between subjective norms and behavioural intention to use HIT
- **H28**: The moderator in TAM3 (experience) has significantly influence extended paths relationships between (subjective norms; ease of use) and (behavioural intention), (subjective norms; ease of use) and (usefulness), and (computer anxiety, computer playfulness, perceived enjoyment) and (ease of use).

6 The Survey Analysis and Finding

6.1 Introduction

This chapter discusses the descriptive findings of the survey questionnaire and Structural Equation Modelling (SEM) analysis. Firstly, Section 6.2 provides an overview of Structural Equation Modelling (SEM), the technique that has been used in this research. Subsequently, as the descriptive data analysis was preferred as a way to analyse the questionnaire data. Frequency and percentage are calculated for every variable (Appendix B and Appendix C) where responses' summary to specific questions are given. Section 6.3 presents an overview of respondents' profiles. The data screening results are argued and presented in Section 6.4. Statistics (demographic data) are introduced in Sections6.5 and 6.6. Next, in Sections 6.7, 6.8, 6.9, 6.10 the SEM approach in combination with the PLS technique and the results of the data analysis are presented for both the CRP and Nurtal studies. Lastly, the finding of the hypotheses testing is presented in the ensuring section.

6.2 Structural Equation Modelling (SEM)

SEM has been used in literature since the 1980s (Hair, Ringle and Sarstedt, 2011). According to Hair et al. (2011) SEM has been discussed in papers since the eighties. In the previous decade, SEM gained popularity in IS research studies. Gefen, Straub, and Boudreau (2000) strongly suggest SEM in scientific behavioural studies and especially in IT/IS research. SEM technique is helpful for researchers in investigating a group of related study questions in sole, methodical and inclusive analysis through forming the association among covert variables and independent and dependent constructs concurrently (Gefen, Straub and Boudreau, 2000).

There are two kinds of measurement scale in SEM: formative or reflective. If the indicators cause the latent variable and are not interchangeable among themselves, they are formative (Petter, Straub and Rai, 2007). However, if the indicators are highly correlated and interchangeable, they are reflective and their reliability and validity have to be carefully inspected (Petter, Straub and

Rai, 2007; Hair Jr *et al.*, 2016). Since all of the indicators in this study are reflective, the reflective analysis was applied.

SEM can be classified in two practices: covariance-based and component-based SEM. The emphasis of CB-SEM is on duplicating the covariance matrix of the theory without the variance illustration. PLS-SEM is a causal modelling approach aimed at explaining the variance of the dependent latent constructs (Hair, Ringle and Sarstedt, 2011). A brief comparison between CB-SEM and PLS-SEM in their analysis points, statistical assumption and other points in Table 6-1.

Table 6-1 Comparison between Covariance-based and Component-based SEM

Criteria	Covariance-based	Component-based
Objective	Parameter oriented	Prediction oriented
Approach	Covariance-based	Variance-based
Implications	Optimal for parameter accuracy	Optimal for prediction accuracy
Statistical assumptions	Multivariate normality (Parametric)	Predictor specification (Non-parametric)
Required Theory Base	Requires sound theory base	Does not require sound theory base
Required minimal sample size	Minimal recommendations range from 200 – 800 cases	At least 10 times the number of items in the most complex formative construct
Model complexity	Small to moderate complexity (e.g., less than 100 indicators)	Large complexity (e.g., 100 constructs and 1000 indicators)
Model evaluation	Goodness of fit, overall model fit, $\chi 2$, AGFI	High R-square, significant *t*-values, jack-knifing or bootstrapping for significance test,
Epistemic relationship between latent variable and its measures	Can be modelled in reflective mode only	Can be modelled in both formative and reflective mode
Best suited for:	Confirmatory research and theory testing	Exploratory research and theory building

Source: Adapted from Gefen, Straub and Boudreau (2000).

There are three reasons for choosing PLS-based approach in this research. First reason, the PLS-based prediction aptitude is the best in matching the objective of the study that identify HIS factors of success. Second reason, complex structural models with a huge number of constructs can be explicate by PLS-SEM. Third reason, a smaller sample mass is needed in comparison to other analysis approaches. Finally, the reflective and formative hypotheses can be easily handled by PLS-SEM (the research model has 78 indicators) (Indicators are also known as items or manifest variables) (Urbach and Ahlemann, 2010). It is important to declare that it is the technique used by Venkatesh and Bala, (2008) as they analysed and tested the original TAM3 model.

According to Hair et al. (2011), the software packages available to use are for SEM includes LISREL, EQS and AMOS. However, the tools used in PLS-SEM are usually PLS-Graph, PLS-PC, PLSIGUI and SmartPLS. The selected tool in this study was SmartPLS software. SPSS (Version 22.0) was used in the descriptive data analysis to define the features of the research data. The participants' profile, and data screening are presented in the descriptive analysis.

According to Hai et al (2010), the two major phases of PLS assessment are: The first phase, the measurement evaluation model that denotes the theory and states the measured variables combination of covert factors symbolism. The second stage, the structural model assessment that explains the theory and identifies the relationship of different constructs in the model.

6.2.1 Measurement Model Assessment

The measurement model demands an evaluation to guarantee the preciseness of the structural model. By inspecting the construct validity in the initial step of PLS assessment, the efficacy of the measurement model is evaluated. Cooper and Schindler, (2013) stated that construct validity is the indicator of a research tool as an evidence based on the theory. Practically, this effectiveness tests if the questions embodies the factors in a theoretical framework. Sekaran and Bougie, (2016) emphasises that construct validity of a research tool is assessed by two fundamental units: 1) convergent validity and 2) discriminant validity.

Convergent validity is settled by measuring Indicator reliability, Composite reliability and finally Average Variance Extracted (AVE). Indicator reliability is evaluated by checking the item's loadings to its parallel latent construct. If the loading is lower than 0.7 then the item is eliminated. Low loading can appear because of poorly worded questions in a questionnaire (item) (Hulland, 1999). Jupp (2006) points out that Internal consistency is a degree of reliability and Cronbach’s Alpha is a classic equipment used to evaluate internal consistency to indicate how various research items complement each in case of measuring the same perception and from one scale. Composite reliability is like Cronbach’s Alpha but it is more advanced, but the former does not consider that all indicators are similarly reliable (Hair, Ringle and Sarstedt, 2011). Fornell and Larcker (1981) confirm that the data can be treated as homogeneous when a Composite reliability is greater than 0.7 as seen in Table 6-2. Finally, Average Variance Extracted (AVE). The adequate value for Composite reliability is bigger than 0.7 and for AVE is 0.5. The AVE amounts must be more than 0.5 for approximate validity to be adequate. As a result, the latent variables clarify further than half of the indicators.

In SmartPLS, The Indicator Reliability, outer loading can be establish beneath the Outer Loading report in SmartPLS following the PLS calculation. However Composite Reliability and Cronbach Alpha is automatically generated, where the scores can be found in the report tab in SmartPLS (Lowry and Gaskin, 2014).

Table 6-2 Interpretation of Composite Reliability

Composite reliability	Internal Consistency
More than 0.9	Excellent
0.8 to 0.9	Good
0.7 to 0.8	Acceptable
Lower than 0.5	Unacceptable

Discriminant validity: Cooper and Schindler (2013, p. 259) define it as “the degree to which scores on a scale do not correlate with scores designed to measure different constructs”. Discriminant validity shows the degree to which an assumed construct is distinctive to other latent constructs (Vinzi *et al.*, 2010). It can be assessed by: 1) reviewing the square root of each AVE which must be more than any correlations among any couple of the latent variables(Fornell and Larcker, 1981) and 2) indicator’s loading that must be larger than all of its cross loadings (Gefen, Straub and Boudreau, 2000). The first evaluation type is purposed to measure at the construct level and the second assessment is for the indicator level(Barclay, Higgins and Thompson, 1995).

In SmartPLS, the Latent Variable Correlation and a new table with the square root of AVE can be found in discriminant validity report on “Cross Loading and Fornell and Larcker” sections (Wong, 2013).

6.2.2 Structural Model Assessment

Only once the reliability and validity of the constructs have been established can the structural model be assessed. A structural model expresses the methods or relationships between the endogenous (dependent variable) and exogenous (independent variable) constructs. Likewise, the structural model allows second order factor modelling. This model is suitable when conceptual models are at a higher level of abstraction.

Generally, the assessment of the structural model associates with examining the explanatory power and significance of the path coefficients among the latent constructs (Chin and Newsted 1999). In order to estimate the predictive power of the exogenous variables in the structural model, the R^2 value for every endogenous variable must be computed. According to Barclay, Higgins, and Thompson (1995) R^2 is understood like the results of multiple regression analysis besides they specify the amount of variance of endogenous variable that is explained by the model. Chin (1998) suggested that the values of R^2 that above 0.67 however values ranging from 0.33 to 0.67 are moderate, whereas value between 0.19 to 0.33 are weak and any R^2 value less than 0.19 are unacceptable. Yet, Falk and miller (1992) propose an R-squared value of 0.10 as minimum acceptable level.

In contrast, by performing bootstrapping on the structural model, path coefficients can be gained. The traditional *t*-test and the results are used to interpret the importance of the paths and bootstrapping is similar to it. By assessing the path coefficients, the hypothesis for each path can then be examined. As the path coefficients in regression, it can also be interpreted in the same method. They specify the power of the relationships between latent constructs (Chin 1998b).

Moreover, the structural model supports the evaluation of mediating (indirect) effects, direct effects and total effects of the exogenous variables on the endogenous variables. A direct effect represents the relationship between an exogenous and endogenous variable. On the other hand, an indirect effect, is the effect of an exogenous on the endogenous variable by one or more intervening variables (Hoyle 1995). Both direct and indirect effects of an exogenous on the endogenous variable sum offers the total effect.

In conclusion, the structural model is measured by its moderating effects. Once a variable changes the effect between two related latent constructs, a moderating effect occurs (Hair et al. 2010). In this study, as the hypothesised moderators (i.e., education, age, gender) are categorical variables, the multi-group process was selected to examine the hypothesised moderating effects. Table 6-3 sums up the analyses for this study and the results of the data analysis are presented in the next section.

Table 6-3 Summary of the PLS analysis

PLS Assessment	Analysis	SmartPLS	Threshold
Stage 1 Assessment of the Measurement Model	Convergent Validity • Indicator reliability analysis • Internal consistency analysis • AVE number	• Outer loading numbers • Reliability number, Composite reliability • AVE number	• The indicator's outer loadings to find the indicator reliability value **0.7 or higher** is preferred. (Hulland, 1999). Consider **Cronbach's alpha** as a conservative measure of internal consistency reliability • Composite reliability **is 0.7 or Higher.** (Bagozzi & Yi, 1988). • AVE is **0.5 or Higher** (Bagozzi & Yi, 1988)
	Discriminant Validity • Cross-loadings analysis • Average variance extracted analysis	AVE number and Latent Variable Correlations	The **square root** of AVE of each latent variable should be greater than the correlations among the latent variables (Fornell & Larcker, 1981)

Stage 2 Assessment of the Structural Model	• Coefficients of determination (R^2) • Predictive relevance (Q^2) • Size and significance of path coefficients • f^2 effect sizes • q^2 effect sizes	• R Square (Quality Criteria) • F Square (Quality Criteria) • Q Square (Total – Blindfolding)	Acceptable level of R^2 (Chin, 1998). • R^2 above 0.67 – high • R^R from 0.33 to 0.67 – Moderator • R^2 from 0.19 to 0.33 – Weak • R^2 Less 0.19 – unaccepted • Acceptable level of f^2 • f^2 above 0.35 – large • f^2 from 0.15 to 0.35 – Medium • f^2 from 0.02 to 0.15 – Small • f^2 less than 0.02 – No Effect

6.3 The Respondents Profile

The total number of nurses in PSMMC was around 2800 and 65 pharmacists. The CPR survey was completed by 281 out of 400 paediatrics nurses. The response rate was found to be 70% of sample. The Pharmatal survey was completed by 47 out of 65 pharmacists about 72.3%. For the Nurtal survey, it was difficult to distribute to all nurses due to the large number, limited nurses' time and the difficulty to access some wards. To test the hypothesis in the model with reliable estimates, the present studies aims to achieve the minimum of 373 workable sample sizes (after treating missing data). (As explained in Chapter 3 on the sample size section 3.5.5.1.3). By examining the nurses and records with head nurses, the total number of potential respondents was found to be 900 nurses. The actual number of respondents to the survey questionnaire is 471 nurses. The response rate is found to be 52% of sample.

The rest of this chapter shows the attempt to reveal what Marsh and Elliott (2008) called "what does this data say?". The following are data screening and some tables showing the respondents' profile as early findings of the survey questionnaire for each survey.

6.4 Data Screening and Management

Before starting the analysis processing, pre-analysis data screening was performed on the initial data. Data screening is a basic step before starting the data analysis to avoid incorrect outcomes and results (Field, 2005). Levy (2006) emphasises on screening as a vital step in the analysis process for four reasons: first, to confirm the collected data; second, to study utmost cases, or outliers and fix them; third, to process missing data values; and fourth, to control the response set issues (Levy, 2006). Accordance to Hair *et al*. (2010), the data screening procedure fundamental issues are such as missing data, univariate normality, and outliers, which are associated to the TAM3 model variables.

Missing data is one of the regular barriers in data analysis in social research (Kline, 2005; Tabachnick & Fidell, 2007). Consequently, an important step before starting the analysis process is to locate and treat any sort of missing data, for example, incomplete answers or missing sections (Hair *et al.*, 2010). In this study, any questionnaire with many missing answers related to the TAM3 model especially was ignored. Arbuckle, (2006) stated that any missing data in the TAM3 model (constructs or variables) will affect some problems in computing the fit measures for instance, Goodness-of-Fit-Index (GFI) in PLS-SME using SmartPLS. As mentioned, a total of 917 out of 1375 (66.9%) of questionnaires were returned from all the three surveys. Of the questionnaires collected, 85 questionnaires were considered unusable because they had many missing response items, which made them useless according to the researcher's rule. 17 questionnaires were data screened in order to fill in the missing data by using IBM SPSS. The remaining 815 (59.3%) questionnaires were completed (after data screening) and used in the analysis. This response rate is considered sufficient considering that, as Sekaran (2003) indicates that a response rate of 30% is acceptable for surveys.

Hair et al. (2010) state that it is essential and useful to test whether the data could have been created by a common theoretical distribution before empirically fitting the distributions to data. Normality refers according to Hair et al. (2006) to the form of the data distribution for a single variable and its influence on the normal distribution. Hair et al. (2006) also emphasises that univariate regularity can be examined graphically or statistically. In fact, testing univariate of normality statistical techniques are Pearson's skewness parameter, whereas the graphical analysis is a visual test of the histogram that compares the experiential data values with a distribution approximating the standard distribution. In this study, to test the univariate normality, visual check of the histogram of the data was used. According to Field (2005), the statistical techniques of testing regularity are sensitive to the size of research data; thus, to estimate univariate normality, it is suggested to check the histogram through the values of skewness and kurtosis. Similarly, in this study, visual assessment of the histogram of the data distribution of all constructs confirmed that the aspect of all the univariate distributions were reasonably normal and acceptable. Moreover, the results in Table 6-4 and Table 6-5 indicate that all values of the variables were within the agreeable range of skewness and kurtosis (i.e. -2.58 +2.58, Hair et al., 2006, p. 82).

Table 6-4 Kurtosis and Skewness Statistics for the CPR System Variables (N = 281)

Scale	Kurtosis	Skewness
PU1	2.462	-1.707
PU2	3.584	-1.914
PU3	2.893	-1.742
PU4	3.849	-2.009
PU5	6.976	-2.528
PEOU1	5.329	-2.271
PEOU2	4.963	-2.113
PEOU3	2.758	-1.725
PEOU4	-0.812	-0.485
PEOU5	2.120	-1.602
PEOU6	0.696	-0.998
CANX1	-0.260	-0.629
CANX2	-1.075	0.036
CANX3	-0.910	0.251
ENJ1	0.248	-0.603
ENJ2	1.889	-1.175
ENJ3	0.609	-0.840
SN1	2.998	-1.727
SN2	0.904	-1.135
SN3	2.320	-1.563
VOL1	2.423	-1.593
VOL2	1.143	-1.181
VOL3	-0.216	-0.572
IMG1	0.905	-1.135
IMG2	1.028	-1.156
IMG3	0.399	-0.891
PEC1	1.256	-1.173
PEC2	-0.576	-0.474
PEC3	1.650	-1.374
PEC4	1.891	-1.338
PEC5	1.576	-1.249
REL1	2.836	-1.583
REL2	-0.351	-0.665
REL3	1.167	-1.074
OUT1	2.271	-1.324
OUT2	1.997	-1.342
OUT3	1.890	-1.315
RES1	1.628	-1.315
RES2	1.566	-1.231
RES3	1.533	-1.155
RES4	-0.716	-0.503
BI1	2.240	-1.355
BI2	2.093	-1.343
BI3	3.131	-1.619
UI1	0.225	-0.918
UI2	0.511	-0.919
UI3	0.290	-0.829
UI4	0.233	-0.715
USE1	4.842	-1.812
USE2	-0.837	-0.688
USE3	-0.472	0.813
CSE1	-0.454	-0.526
CSE2	-0.419	-0.530
CSE3	-0.227	-0.675
CSE4	-0.286	-0.659
CPLAY1	0.857	-1.101
CPLAY2	0.248	-0.800
CPLAY3	-0.180	-0.644
CPLAY4	-1.040	0.195
UT1	0.558	-0.974
UT2	1.707	-1.279

UT3	1.595	-1.244
UT4	0.617	-0.953
UT5	1.337	-1.176
UT6	4.249	2.137
Age	0.780	1.323
Gender	11.824	11.824
Nationality	2.378	-0.242
Experience	-1.219	-0.343
Education	6.719	-0.576
JobTitle	4.615	-2.298

Note. SE for skewness statistic = 0.08. SE for kurtosis statistic = 0.17.

Table 6-5 Kurtosis and Skewness Statistics for the Nurtal System Variables (N = 62)

Scale	Kurtosis	Skewness
PU1	0.332	-0.820
PU2	0.371	-0.897
PU3	0.194	-0.818
PU4	0.715	-0.770
PU5	1.005	-0.919
PU6	1.452	1.080
PU7	1.527	-1.150
PU8	0.183	-0.857
PU9	0.508	-0.821
PEOU1	0.451	-0.850
PEOU2	-0.201	-0.638
PEOU3	0.295	-0.780
PEOU4	-0.253	-0.461
PEOU5	-0.149	-0.586
PEOU6	0.038	-0.442
CANX1	-0.028	-0.523
CANX2	-0.642	-0.155
CANX3	-1.098	0.142
CANX4	-0.738	0.494
ENJ1	0.244	-0.335
ENJ2	0.165	-0.367
ENJ3	0.399	-0.384
SN1	1.907	-1.400
SN2	0.221	-0.843
SN3	0.436	-0.834
SN4	0.352	-0.806
VOL1	1.213	-1.080
VOL2	1.616	-1.104
VOL3	0.076	-0.477
VOL4	-1.019	0.666
IMG1	0.582	-0.769
IMG2	0.116	-0.562
IMG3	0.375	-0.634
PEC1	0.629	-0.919
PEC2	-0.644	-0.289
PEC3	-0.288	-0.477
PEC4	-0.576	-0.448
PEC5	0.159	-0.592
REL1	0.356	-0.757
REL2	0.019	-0.473
REL3	0.294	-0.556
REL4	0.398	-0.720
OUT1	0.186	-0.578
OUT2	0.146	-0.526
OUT3	0.325	-0.577
RES1	0.084	-0.469
RES2	0.410	-0.500
RES3	-0.105	-0.372
RES4	-0.325	-0.381
BI1	0.796	-0.779
BI2	0.848	-0.767
BI3	0.744	-0.838
UI1	0.469	-0.823
UI2	0.362	-0.512
UI3	0.284	-0.579
UI4	-0.097	-0.415
USE1	-1.290	0.265
USE2	20.236	-4.079
USE3	0.245	-0.752
CSE1	0.061	-0.890
CSE2	-0.027	-0.731
CSE3	0.050	-0.889
CSE4	0.269	-0.833
CPLAY1	0.453	-0.803
CPLAY2	0.238	-0.587
CPLAY3	0.166	-0.605
CPLAY4	-0.737	0.057
UT1	0.323	-0.497
UT2	-0.272	-0.387
UT3	0.004	-0.415
UT4	0.004	-0.415
UT5	0.083	-0.444
UT6	-0.637	-0.276
Age	0.064	0.983
Gender	2.232	-2.055
Nationality	11.977	0.514
Experience	-1.060	-0.354
Education	9.840	-1.986
JobTitle	14.154	-3.539

Note: SE for skewness statistic = 0.08. SE for kurtosis statistic = 0.17.

6.5 Demographic Analysis for CPR Survey

Table 6-6 below illustrates the CPR system group in terms of demographic data, as age, gender, nationality, education, and job title.

Table 6-6 Demographic information of CPR System

Variable		Frequency	Percent
Gender	Male	17	6.03%
	Female	265	93.97%
Age	20-30	189	67.02%
	31-40	48	17.02%
	41-50	34	12.06%
	50>	11	3.90%
Experience	Less than a year	42	14.89%
	1-2 Years	70	24.82%
	3-5 Years	68	24.11%
	More than 5 Years	102	36.17%
Nationality	Saudi	49	17.38%
	Filipino	221	78.37%
	Indian	11	3.90%
	Jordanian	1	0.35%
Education	Diploma	30	10.64%
	Bachelor	246	87.23%
	Master	5	1.77%
	Doctor	1	0.35%
Job Title	Head Nurse	1	0.35%
	Charge Nurse	16	5.67%
	Nursing Team Leader	8	2.84%
	Staff Nursing 1	66	23.40%
	Staff Nursing 2	191	67.73%

6.5.1 Gender and Age

Table 6-6 shows the respondents' of the study sample profile. 265 (93.97%) of the CPR system group are female and 17 (6.03%) are male. The age distribution illustrates that more than half of the respondents (67.02%) age range is (20 to 30) and the second group (17.02%) age group is (31 to 40). 12.06% percentage of the sample are between (41 to 50) years old and finally 3.90%. percentage are older than 51 years.

6.5.2 Experience

Table 6-6 shows the low experience of participant nurses on the survey which represent a third quarter of the sample.

6.5.3 Nationality

Respondents were requested to specify their nationality, and as clear in Table 7.2, more than two thirds (78.37%) of the sample are Filipinos, while 17.38% are Saudis. A slight percentage, about 3.90%, are Indian. Finally, only one (0.35%) participant is Jordanian.

6.5.4 Education Level

Respondents are requested to state their education level. As shown in Table 7.2, the majority of nurses (87.23%) are bachelor degree holders, whereas 22.0% are diploma degree holders. Almost 8.2% have got the masters degrees. Finally, only one person 0.35% has a doctor degrees.

6.5.5 Job Title

Table 6-6 shows that about two thirds (67.73%) are Staff Nursing 2. Approximately, a quarter of the sample (23.40%) are Staff Nursing 1. Finally, only one person 0.35% is a Head Nurse.

6.6 Demographic Analysis for Nurtal Survey

The Table 6-7 presents a general overview of the Nurtal group in terms of demographic information, as age, gender, nationality, education, and job title.

Table 6-7 Demographic information of Nurtal system

Variable		Frequency	Percent
Gender	Male	67	14.23%
	Female	404	85.77%
Age	20-30	287	60.93%
	31-40	124	26.33%
	41-50	51	10.83%
	50>	9	1.91%
Experience	Less than a year	43	9.13%
	1-2 Years	130	27.60%
	3-5 Years	130	27.60%
	More than 5 Years	168	35.67%
Nationality	Saudi	25	5.31%
	Filipino	429	91.08%
	Indian	15	3.18%
	Jordanian	2	0.42%
Education	Diploma	29	6.16%
	Bachelor	436	92.57%
	Master	6	1.27%
	Doctor	0	0.00%
Job Title	Head Nurse	1	0.21%
	Charge Nurse	10	2.12%

	Nursing Team Leader	5	1.06%
	Staff Nursing 1	79	16.77%
	Staff Nursing 2	376	79.83%

6.6.1 Gender and Age

Table 6-7 illustrates the profile of respondents of the study sample. 404 (85.77%) of Nurtal group are female and only 67 (14.23) are male. The age distribution illustrates that more than half of respondents 287 (67.93%) age range is (20 to 30) and the second group (26.33%) age is (31 to 40). (10.83%) percentage of the sample are between (41 to 50) years old and finally (1,91%). percentage are older than 51 years.

6.6.2 Experience

In Table 6-7, it is clear that about two thirds of sample 303 (64.33%) have low experience (less than 5 year). Meanwhile, about a third of respondents 168 (35.67%) have more than 5 year experience.

6.6.3 Nationality

Respondents were requested to specify their nationality, and as clear in Table 6-7, almost all the participant of the survey (91.08%) of the sample are Filipinos, while (5.31%) 25 are Saudis. A small percentage, about (5.31%) are Indian. Finally, only two (0.42%) participants are Jordanian.

6.6.4 Education Level

Respondents are requested to state their education level. As shown in Table 6-7, the majority of nurses (92.57%) are bachelor degree holders, whereas (6.16%) are diploma degree holders. Almost (1.22%) have got the masters degrees. Finally, no one (0.00%) has a doctor degrees.

6.6.5 Job Title

Table 6-7 shows that more than two thirds (79.83%) are Staff Nursing 2. Approximately, less than a quarter of the sample (16.77%) are Staff Nursing 1. Finally, the rest of participants were in the following percentage: Charge Nurse are (2.12%), Nursing Team Leader are (1.06%), and (0.21%) is a Head Nurse.

6.7 Summarise Demographic Data Results

The average summary of all the two-demographic data sample in the survey results reveals that female respondents are 79.78% of the sample. Meanwhile, the male respondents are 20.22%. Almost two thirds 63.2% of the respondents are below 30 years of age. This statistics tells the most of the sample respondents are females and males under the age of 30 which indicates their technology awareness.

In terms of experience, 38.8% of respondents have more than five years of work experience in HIT implementation in hospital system. This shows that 61.2% of respondents can be classified as less experts (less than five year) in HIT implementation. This community suggests that most respondents are 'early career' in HIT implementation.

Concerning education level, 90% of respondents have at least a bachelor's degree. Almost 90% of respondents are non-Saudi. This indicates that, in general, there is a kind of mixture in culture and expertise of roles and regulation in hospital. However, this should not influence the medication practices. Likewise, this represents the minimal requirement level of employment of non-Saudi.

6.8 Data Analysis Technique (PLS-SEM)

There are two major phases in PLS assessment: the first stage, the assessment of the measurement model is performed. The second stage, the assessment of the structural model.

6.9 Data Analysis for CPR Survey

6.9.1 Assessment of the Measurement Model

The evaluation measurement model is via two major analyses: 1) convergent validity; 2) discriminant validity.

6.9.1.1 Convergent Validity

The convergent validity in PLS is the initial test while analysing data, which is typically mentioned as a reliability analysis Indicator, internal stability and Average Variance Extracted (AVE). This is to measure the loadings of items on its respective covert construct. That is to find the items loadings, composite reliability, and AVE that the PLS-Algorithm method calculated. The item results reliability are shown in Table 6-8 and is illustrated in Figure 6-1.

Table 6-8 Reliability and Validity Assessment of the Model (CPR System)

Latent Variable	Indicators (item)	Loading	Cronbach Alpha	Composite Reliability	AVE
Perceived Usefulness	PU1	0.890	0.944	0.957	0.817
	PU2	0.925			
	PU3	0.899			
	PU4	0.889			
	PU5	0.916			
Perceived Ease of Use	PEOU1	0.884	0.878	0.911	0.645
	PEOU2	0.910			
	PEOU3	0.853			
	PEOU4	0.365			
	PEOU5	0.848			
	PEOU6	0.823			
Computer Anxiety	CANX1	0.975	0.712	0.562	0.383
	CANX2	0.418			
	CANX3	0.151			
Perceived Enjoyment	ENJ1	0.899	0.869	0.920	0.792
	ENJ2	0.923			
	ENJ3	0.847			
Subjective Norm	SN1	0.913	0.869	0.920	0.793
	SN2	0.847			
	SN3	0.910			
Image	IMG1	0.892	0.825	0.895	0.741
	IMG2	0.891			
	IMG3	0.796			
Output Quality	OUT1	0.935	0.935	0.888	0.925
	OUT2	0.888			
	OUT3	0.925			
Perceptions of External Control	PEC1	0.908	0.857	0.898	0.641
	PEC2	0.939			
	PEC3	0.928			
	PEC4	0.328			
Job Relevance	REL1	0.881	0.630	0.790	0.578
	REL2	0.412			
	REL3	0.888			
Result Demonstrability	RES1	0.908	0.918	0.948	0.859
	RES2	0.939			
	RES3	0.928			
	RES4	0.328			
	BI1	0.895	0.895	0.935	0.827

Behavioural Intention	BI2	**0.917**			
	BI3	**0.916**			
Use Behaviour	USE1	**0.694**	**0.132**	**0.575**	**0.361**
	USE2	**0.760**			
	USE3	**0.156**			
Computer Self-Efficacy	CSE1	**0.833**	**0.861**	**0.902**	**0.697**
	CSE2	**0.843**			
	CSE3	**0.857**			
	CSE4	**0.805**			
Computer Playfulness	CPLAY1	**0.901**	**0.708**	**0.808**	**0.559**
	CPLAY2	**0.925**			
	CPLAY3	**0.735**			
	CPLAY4	**0.166**			
User Involvement	UI1	**0.880**	**0.918**	**0.942**	**0.803**
	UI2	**0.922**			
	UI3	**0.905**			
	UI4	**0.877**			
User Training	UT1	**0.767**	**0.791**	**0.866**	**0.589**
	UT2	**0.840**			
	UT3	**0.830**			
	UT4	**0.843**			
	UT5	**0.898**			
	UT6	**-0.193**			

The Nunnally (1967) and Fornell and Larcker (1981) reliability guideline of 0.7 or higher is adopted in this study. Hulland (1999) emphasises that loadings of 0.7 or more imply that the shared variance between the construct and its measure is more than the error variance which indicates that more than 50% of the variance is accounted for by the respective construct. According to Hulland (1999), 0.7 loadings or more denotes that the construct and its measure shared variance that is higher than the error variance. Consequently, ten measurement items (PEOU4, CANX2, CANX3, PEC4, REL2, RES4, USE1, USE3, CPLAY4 and UT6) were deleted after the initial operation. The following convergent assessment validity is used for internal consistency assessment. Table 6-9 reports the internal consistency results.

Table 6-9 Internal Consistency of the Model (CPR System)

	Cronbach's Alpha	Composite Reliability	AVE
Perceived Usefulness	0.944	0.957	0.817
Perceived Ease of Use	0.916	0.937	0.750
Computer Anxiety	1.000	1.000	1.000
Perceived Enjoyment	0.869	0.920	0.792
Subjective Norm	0.869	0.920	0.793
Image	0.825	0.895	0.741
Output Quality	0.905	0.940	0.840
Perceptions of External Control	0.865	0.908	0.714
Job Relevance	0.750	0.889	0.800
Result Demonstrability	0.918	0.948	0.859
Behavioural Intention	0.895	0.935	0.827
Use Behaviour	1.000	1.000	1.000
Computer Self-Efficacy	0.861	0.902	0.803
Computer Playfulness	0.822	0.892	0.735
User Involvement	0.894	0.942	0.803
User Training	0.894	0.922	0.704

The results analysis illustrates convergent validity and accepted the internal consistency in the model measurement. The compound reliability has surpassed the standard cut-off point of 0.7 and the AVE is more than 0.5. In addition, in Cronbach’s, the values are above the minimum requirement of 0.7 for all constructs which suggest good internal consistency (Fornell and Larcker 1981; Nunnally 1978). Hence, the reliability of all latent constructs was verified.

Figure 6-1 is the graphics display from SmartPLS. In a reflective measurement scale, the causality direction is going from the blue coloured latent variable to the yellow coloured indicators.

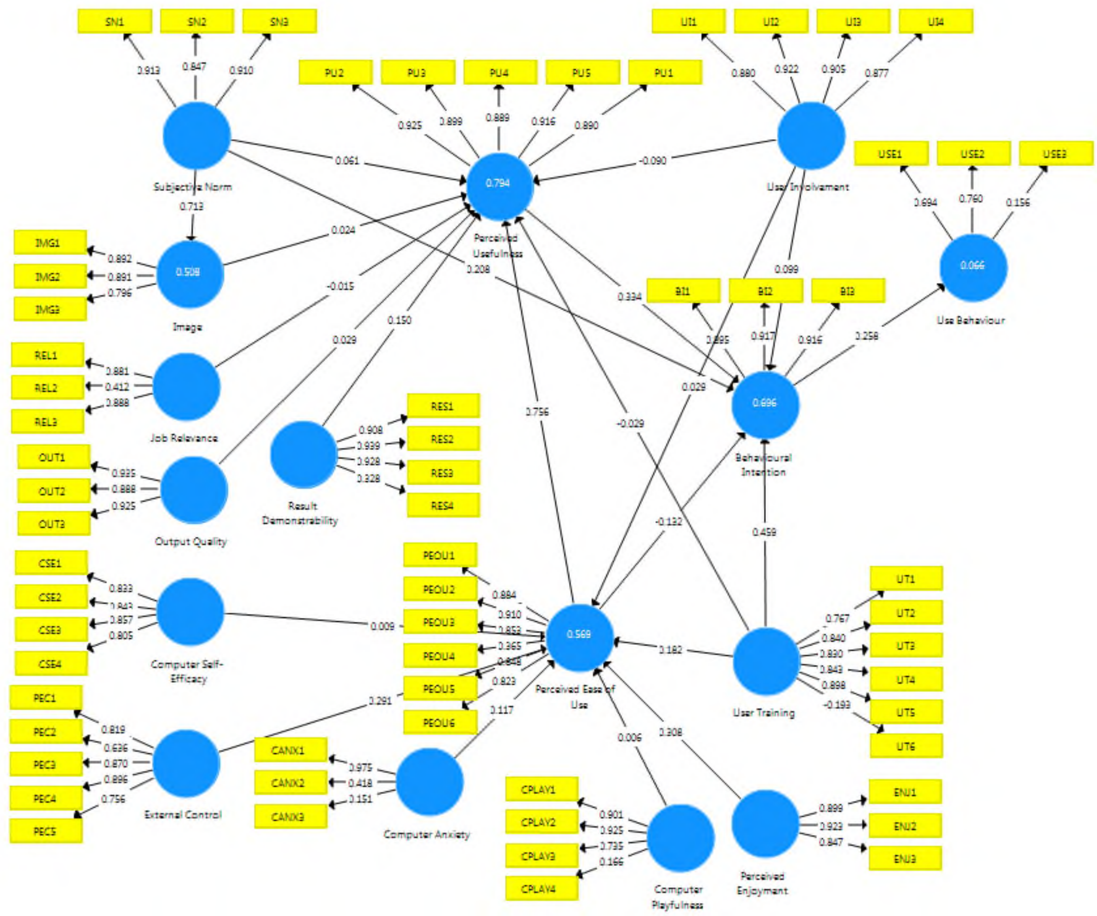


Figure 6-1 PLS Results of Initial Measurement (CRP System)

6.9.1.2 Discriminant Validity

After assessing the convergent validity of the measurement model, the discriminant validity of the measurement was evaluated. To determine discriminant validity two tests were required: 1) analysis of cross-loadings and 2) analysis of Average Variance Extracted (AVE).

Analysis of cross-loadings involves the examination of loadings of the items with respect to the correlations of all constructs. The cross-loading results in Table 6-10 revealed that all items load higher on their respective constructs in comparison to their cross-loadings on the other constructs. For example, all four items (i.e., CSE1, CSE2, CSE3 and CSE4) for Computer Self-Efficacy (CSE) construct loaded higher on TM as compared to other constructs (i.e., PU, PEOU, CANX, ENJ, SN, IMG, PEC, REL, BI, USE, CPLAY and UT). This confirms that the measurement model has strong discriminant validity at the item level and meets the first discriminant validity norm.

The second assessment in discriminant analysis was to examine the AVE shared between a construct and its measures as proposed by Fornell and Larcker (1981). Fornell & Larcker (1981) examined discriminant validity by the square root of AVE of each latent variable should be greater than the correlations among the latent variables. From Table 6-11 the square root of AVE of each latent variable was written in bold. For example, The ENJ's AVE was 0.792 therefore, the square root of it was 0.890. The RES's AVE was 0.859, then the square root of it was 0.927. For Discriminant validity testing, for example, ENJ's AVE, 0.890 need to compare with construct cross-correlation which were 0.653 from PEOU, 0.615 from REL, 0.602 from IMG, 0.680 from PEC, 0.247 from CSE, 0.340 from CPLAY, 0.160 from CANX and 0.623 from BI. Then, when consider other variables' AVE compare with cross-correlation, the AVE were greater than the correlations. Therefore, the results demonstrate that the square root of AVE on the diagonal is greater than the off-diagonal elements across the row and down the column. Therefore, this finding indicates that the results are satisfactory and confirms the establishment of the discriminant validity at the construct level.

The measurement model results indicate that the construct reliability, indicator reliability, convergent validity, and discriminant validity of the constructs are satisfactory. The constructs can be used to test the structural model.

Table 6-10 Cross-Loadings of Items (CPR system)

	BI	CANX	CPLAY	CSE	PEC	IMG	REL	OUT	PEOU	ENJ	PU	RES	SN	USE	UI	UT
BI1	**0.896**	0.135	0.278	0.272	0.684	0.605	0.675	0.703	0.633	0.613	0.640	0.745	0.699	0.180	0.487	0.679
BI2	**0.916**	0.168	0.296	0.253	0.681	0.596	0.630	0.692	0.592	0.538	0.586	0.696	0.604	0.184	0.528	0.709
BI3	**0.916**	0.115	0.308	0.240	0.681	0.580	0.682	0.762	0.634	0.547	0.631	0.754	0.638	0.164	0.473	0.700
CANX1	0.153	**1.000**	0.009	-0.011	0.223	0.208	0.172	0.082	0.211	0.160	0.150	0.094	0.170	0.065	0.068	0.128
CPLAY1	0.342	-0.004	**0.904**	0.393	0.332	0.253	0.295	0.376	0.295	0.295	0.301	0.405	0.353	0.225	0.259	0.355
CPLAY2	0.282	-0.013	**0.927**	0.385	0.375	0.273	0.282	0.364	0.292	0.312	0.316	0.396	0.314	0.115	0.202	0.303
CPLAY3	0.177	0.068	**0.727**	0.397	0.236	0.145	0.144	0.206	0.161	0.276	0.137	0.217	0.176	0.171	0.179	0.199
CSE1	0.253	-0.074	0.441	**0.835**	0.297	0.224	0.188	0.314	0.258	0.249	0.251	0.300	0.300	0.220	0.257	0.277
CSE2	0.219	0.063	0.303	**0.841**	0.249	0.187	0.169	0.244	0.181	0.198	0.205	0.220	0.243	0.113	0.221	0.272
CSE3	0.254	-0.058	0.405	**0.859**	0.222	0.149	0.163	0.264	0.190	0.215	0.242	0.286	0.250	0.170	0.170	0.244
CSE4	0.190	0.102	0.283	**0.803**	0.196	0.166	0.117	0.172	0.115	0.112	0.147	0.166	0.146	0.071	0.174	0.188
ENJ1	0.561	0.121	0.322	0.174	**0.595**	0.525	0.552	0.528	0.548	0.898	0.485	0.563	0.588	0.130	0.425	0.568
ENJ2	0.635	0.147	0.343	0.307	**0.666**	0.602	0.623	0.655	0.670	0.923	0.611	0.677	0.724	0.213	0.449	0.612
ENJ3	0.445	0.161	0.231	0.155	**0.541**	0.467	0.449	0.490	0.506	0.848	0.477	0.468	0.571	0.170	0.322	0.440
IMG1	0.588	0.193	0.205	0.168	0.626	**0.892**	0.559	0.578	0.637	0.599	0.601	0.600	0.707	0.181	0.382	0.538
IMG2	0.559	0.156	0.222	0.186	0.579	**0.891**	0.513	0.538	0.511	0.431	0.486	0.552	0.568	0.170	0.432	0.577
IMG3	0.535	0.187	0.285	0.230	0.643	**0.796**	0.496	0.548	0.545	0.510	0.475	0.513	0.544	0.192	0.459	0.617
OUT1	0.759	0.067	0.388	0.300	0.791	0.654	**0.774**	0.935	0.716	0.601	0.673	0.827	0.718	0.230	0.505	0.740
OUT2	0.682	0.058	0.288	0.272	0.680	0.528	**0.637**	0.888	0.618	0.538	0.562	0.760	0.608	0.203	0.479	0.662
OUT3	0.728	0.097	0.368	0.288	0.735	0.584	**0.682**	0.925	0.718	0.600	0.685	0.840	0.710	0.223	0.491	0.701
PEC1	0.550	0.159	0.370	0.240	0.817	0.582	0.589	**0.632**	0.583	0.588	0.499	0.574	0.595	0.160	0.446	0.649
PEC3	0.691	0.143	0.292	0.264	0.878	0.658	0.710	**0.746**	0.654	0.568	0.603	0.717	0.732	0.177	0.466	0.751
PEC4	0.707	0.211	0.316	0.273	0.905	0.626	0.706	**0.719**	0.650	0.608	0.605	0.679	0.682	0.176	0.460	0.785
PEC5	0.575	0.257	0.295	0.231	0.772	0.542	0.524	**0.612**	0.490	0.535	0.441	0.549	0.507	0.147	0.447	0.613
PEOU1	0.619	0.194	0.249	0.203	0.614	0.593	0.614	0.674	**0.890**	0.522	0.862	0.646	0.741	0.305	0.310	0.547

PEOU2	0.643	0.161	0.278	0.225	0.674	0.615	0.664	0.710	**0.917**	0.563	0.855	0.672	0.758	0.303	0.371	0.609
PEOU3	0.532	0.199	0.235	0.194	0.600	0.506	0.593	0.595	**0.854**	0.536	0.725	0.572	0.675	0.242	0.376	0.541
PEOU5	0.586	0.163	0.276	0.205	0.585	0.564	0.585	0.650	**0.850**	0.579	0.705	0.651	0.685	0.287	0.399	0.571
PEOU6	0.563	0.199	0.274	0.206	0.593	0.579	0.533	0.611	**0.817**	0.635	0.677	0.609	0.629	0.207	0.468	0.542
PU1	0.614	0.100	0.314	0.232	0.559	0.500	0.559	0.630	0.780	**0.508**	0.890	0.653	0.674	0.322	0.320	0.506
PU2	0.677	0.161	0.281	0.249	0.628	0.583	0.610	0.669	0.803	**0.583**	0.925	0.672	0.678	0.236	0.376	0.582
PU3	0.571	0.092	0.327	0.251	0.565	0.531	0.562	0.615	0.764	**0.562**	0.899	0.610	0.624	0.161	0.323	0.502
PU4	0.588	0.147	0.256	0.234	0.557	0.577	0.575	0.581	0.805	**0.507**	0.889	0.603	0.667	0.229	0.319	0.519
PU5	0.622	0.174	0.228	0.229	0.589	0.570	0.587	0.677	0.855	**0.530**	0.916	0.657	0.702	0.271	0.308	0.534
REL1	0.685	0.209	0.297	0.183	0.712	0.572	0.905	0.698	0.658	0.557	**0.600**	0.684	0.686	0.206	0.405	0.697
REL3	0.614	0.094	0.226	0.171	0.635	0.516	0.883	0.666	0.576	0.542	**0.543**	0.644	0.620	0.176	0.452	0.627
RES1	0.727	0.016	0.390	0.268	0.652	0.577	0.664	0.832	0.695	0.550	0.690	**0.913**	0.682	0.292	0.466	0.652
RES2	0.723	0.106	0.377	0.289	0.672	0.590	0.682	0.815	0.649	0.596	0.623	**0.940**	0.683	0.236	0.482	0.675
RES3	0.787	0.145	0.380	0.294	0.764	0.635	0.721	0.812	0.678	0.660	0.651	**0.929**	0.727	0.220	0.527	0.759
SN1	0.673	0.115	0.326	0.260	0.672	0.619	0.698	0.708	0.748	0.646	0.675	0.720	**0.913**	0.315	0.469	0.621
SN2	0.558	0.165	0.277	0.277	0.603	0.579	0.539	0.560	0.609	0.642	0.546	0.572	**0.847**	0.133	0.473	0.515
SN3	0.664	0.176	0.309	0.262	0.725	0.697	0.702	0.707	0.784	0.621	0.740	0.707	**0.910**	0.237	0.417	0.635
UI1	0.473	0.104	0.131	0.202	0.439	0.403	0.425	0.441	0.372	0.335	0.292	0.428	0.417	**0.120**	0.880	0.544
UI2	0.523	0.075	0.241	0.227	0.525	0.484	0.448	0.508	0.427	0.437	0.346	0.484	0.469	**0.102**	0.922	0.559
UI3	0.511	0.027	0.285	0.246	0.524	0.471	0.448	0.513	0.420	0.427	0.371	0.529	0.483	**0.189**	0.905	0.579
UI4	0.442	0.041	0.234	0.235	0.425	0.379	0.385	0.453	0.356	0.419	0.291	0.453	0.438	**0.173**	0.877	0.501
USE2	0.194	0.065	0.195	0.189	0.196	0.210	0.215	0.239	0.312	0.194	0.271	0.270	0.261	1.000	**0.163**	0.206
UT1	0.552	0.117	0.260	0.234	0.645	0.517	0.551	0.582	0.495	0.441	0.435	0.547	0.455	0.158	0.418	**0.771**
UT2	0.688	0.109	0.339	0.248	0.756	0.629	0.666	0.679	0.598	0.554	0.562	0.662	0.625	0.166	0.427	**0.840**
UT3	0.617	0.173	0.266	0.234	0.759	0.609	0.641	0.660	0.548	0.511	0.495	0.618	0.572	0.147	0.459	**0.835**
UT4	0.646	0.065	0.277	0.287	0.618	0.471	0.590	0.618	0.514	0.503	0.454	0.630	0.533	0.182	0.644	**0.845**
UT5	0.694	0.077	0.295	0.269	0.706	0.555	0.654	0.668	0.560	0.551	0.498	0.678	0.594	0.210	0.614	**0.901**

Table 6-11 Latent Variable Constructs (CPR System)

	BI	CANX	CPLAY	CSE	PEC	IMG	REL	PEOU	ENJ	PU	RES	PEOU	SN	USE	UI	UT
BI	**0.909**															
CANX	0.153	**1.000**														
CPLAY	0.323	0.009	**0.857**													
CSE	0.281	-0.011	0.446	**0.834**												
PEC	0.750	0.223	0.375	0.299	**0.845**											
IMG	0.653	0.208	0.272	0.223	0.715	**0.861**										
REL	0.728	0.172	0.294	0.198	0.755	0.610	**0.894**									
OUT	0.790	0.082	0.383	0.313	0.805	0.645	0.764	**0.916**								
PEOU	0.681	0.211	0.303	0.239	0.709	0.661	0.692	0.750	**0.866**							
ENJ	0.623	0.160	0.340	0.247	0.680	0.602	0.615	0.634	0.653	**0.890**						
PU	0.681	0.150	0.310	0.264	0.642	0.611	0.640	0.703	0.887	0.595	**0.904**					
RES	0.805	0.094	0.413	0.306	0.751	0.648	0.743	0.885	0.728	0.649	0.708	**0.927**				
SN	0.712	0.170	0.343	0.298	0.752	0.713	0.732	0.744	0.807	0.712	0.741	0.753	**0.890**			
USE	0.194	0.065	0.195	0.189	0.196	0.210	0.215	0.239	0.312	0.194	0.271	0.270	0.261	**1.000**		
UI	0.545	0.068	0.251	0.254	0.537	0.488	0.477	0.536	0.441	0.452	0.365	0.530	0.505	0.163	**0.896**	
UT	0.765	0.128	0.344	0.303	0.833	0.665	0.742	0.766	0.649	0.613	0.586	0.750	0.667	0.206	0.610	**0.839**

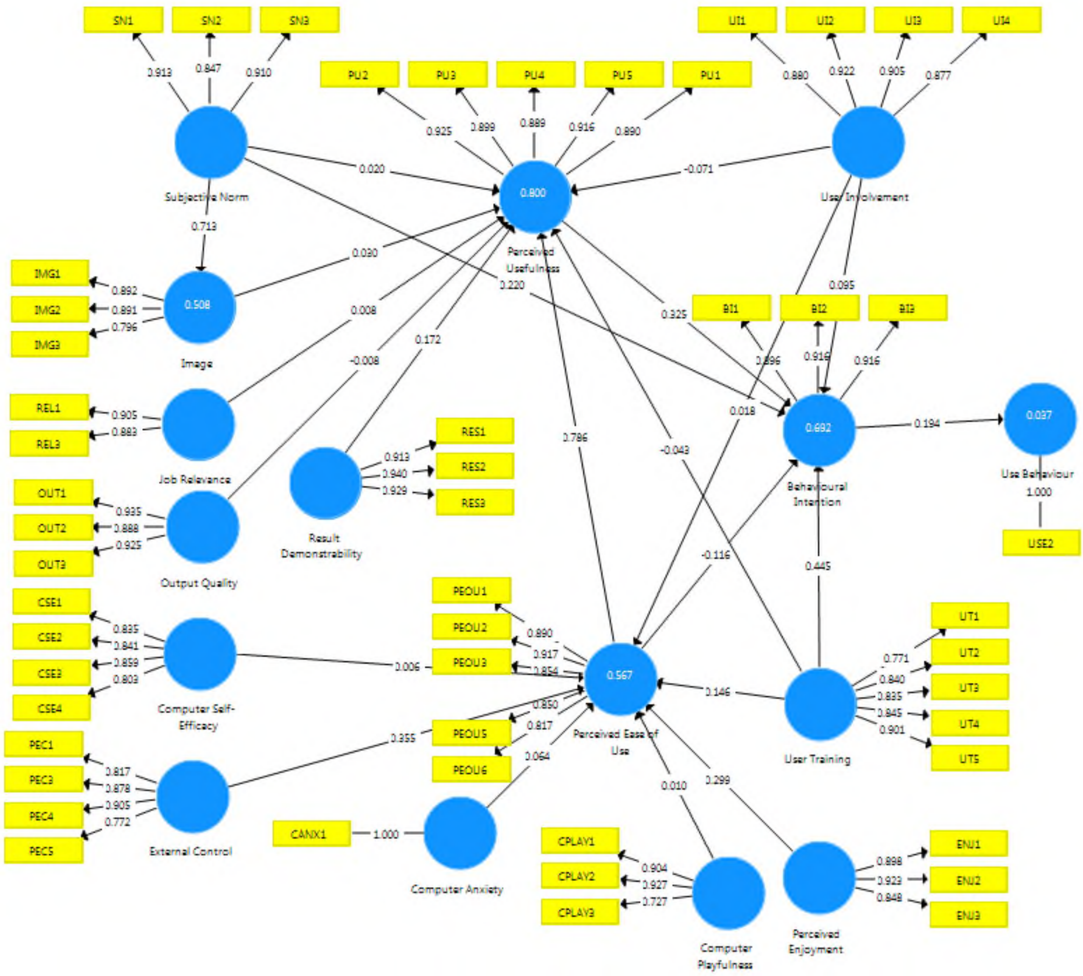


Figure 6-2 PLS Results of Final Measurement (CPR System)

6.9.2 Assessment of the Structural Model

The hypothesised relationship among the latent constructs is included in the structural model. To assess the structural model, the following analyses are required: Coefficients of determination (R^2), path coefficient (hypotheses testing), predictive relevance (q^2).

6.9.2.1 Coefficients of Determination (R^2)

The most critical standard for the assessment of the structural model is the coefficient of determination (R^2) of the dependent variable (Henseler et al., 2009). Larger the R^2 value, means higher predictive capability of the model. The R^2 value specifies the quantity of variance in the construct that the path model explains (Barclay et al. 1995). In Table 6-12 the results are extracted into the structural model.

The R^2 value is interpreted as a manner of regression. Thus, the exogenous constructs results explain 69.2% of the variance in behavioural objective which is the central endogenous construct for the model.

In social sciences research, the R^2 value is regarded as quite substantial (see 4.7.5.2 for acceptable value) (Chin 1998b; Cohen 1988). Falk and Miller (1992) indicate that the R^2 also meets the suggested 0.10 cut-off for the latent construct to be judged sufficient.

Table 6-12 R-Square of the Endogenous Latent Variables (CPR System)

R^2 Values for the Main Model	R Square	Result
Behavioural Intention	0.692	High
Image	0.508	Moderate
Perceived Ease of Use	0.567	Moderate
Perceived Usefulness	0.800	High
Use Behaviour	0.037	Unacceptable

6.9.2.2 Path Coefficient (Hypotheses Testing)

The analysis of hypotheses and constructs' relationships were based on the examination of standardised paths. The path significance levels were estimated using the bootstrap resampling method (Henseler et al., 2009), with suggests numbers that range from 500 iterations of resampling (Chin,1998). Recommended as final run of 5000 sub-sample (Hair et al., 2011). The statistical significance of the paths is controlled by t-values and p-values based on the path coefficient evaluation. Critical t-value at the 0.05 significant level for two-tailed test when $t = 1.96$. So, whatever equal and above 1.96 is considered significant in this study. Table 6-13, presented the results of the hypotheses.

The findings show that half of hypotheses (10 out of 21) was supported in the study. The, PU, SN and UT were found to be strongly statistically significant in explaining behavioural intention, $p<0.001$, supporting hypotheses **H1**, **H5** and **H20**. In the opposite situation are UI and PEOU, which are not statistically significant, not supporting hypotheses **H2** and **H19**.

On the other hand, for perceived ease of use most of the hypotheses showed not significant (5 out of 7). CANX, CPLAY, UI, UT and CSE were found to be not statistically significant in explaining perceived ease of use, $p<0.001$, not supporting hypotheses **H14**, **H15**, **H17**, **H22** and **H12**. The only variables that showed statistically significant PEOU in explaining was PEC p<0.000, and PEC and ENJ supporting hypotheses **H13** and **H16**.

Table 6-13 Path Coefficient of the research hypotheses (CPR System)

H	Relation	Std. Beta	Std. Error	T-value	P-values	Decision
H19	**UI -> BI**	0.095	0.059	1.598	0.055	Not Supported
H2	**PEOU -> BI**	-0.116	0.098	1.184	0.118	Not Supported
H1	**PU -> BI**	0.325	0.080	4.071	0.000	Supported
H20	**UT -> BI**	0.445	0.059	7.532	0.000	Supported
H5	**SN -> BI**	0.220	0.070	3.162	0.001	Supported
H6	**SN -> PU**	0.020	0.057	0.343	0.366	Not Supported
H8	**IMG -> PU**	0.030	0.038	0.788	0.215	Not Supported
H21	**UT -> PU**	-0.044	0.046	0.945	0.172	Not Supported
H9	**REL -> PU**	0.007	0.054	0.137	0.446	Not Supported
H10	**OUT -> PU**	0.001	0.064	0.022	0.491	Not Supported
H11	**RES -> PU**	0.167	0.053	3.158	0.001	Supported
H18	**UI -> PU**	-0.071	0.034	2.126	0.017	Supported
H3	**PEOU -> PU**	0.785	0.057	13.800	0.000	Supported
H14	**CANX -> PEOU**	0.064	0.036	1.763	0.039	Not Supported
H15	**CPLAY -> PEOU**	0.010	0.047	0.210	0.417	Not Supported
H22	**UT -> PEOU**	0.146	0.085	1.716	0.043	Not Supported
H17	**UI -> PEOU**	0.018	0.041	0.438	0.331	Not Supported
H12	**CSE -> PEOU**	0.006	0.043	0.141	0.444	Not Supported
H13	**PEC -> PEOU**	0.355	0.087	4.085	0.000	Supported
H16	**ENJ -> PEOU**	0.299	0.072	4.152	0.000	Supported
H7	**SN -> IMG**	0.713	0.046	15.558	0.000	Supported
H4	**BI -> USE**	0.194	0.060	3.226	0.001	Supported

Note: Significant *p<0.05, **p<0.01, ***p<0.001

6.9.2.3 f^2 Effect Sizes

According to Cohen (1988) the guideline for assessing F^2 are values of 0.02, 0.15, and 0.35, respectively, represent small, medium, and large effect of the exogenous latent variable. Effect size value of less than 0.02 indicate there is no effect. In Table 6-14, 9 out 21 from the relation have large effect. The largest relation is H7 **SN -> IMG.** 3 out 21 of F^2 have small effect size for example **UT -> PEOU.** Finally, 9 out 21 from the of F^2 get no effect **CANX -> PEOU.**

Table 6-14 F-Square effect sizes (CPR System)

H	Relation	Std. Beta	Std. Error	T-value	P-values	Result
H7	SN -> IMG	1.031	0.284	3.630	0.000	Large
H3	PEOU -> PU	0.929	0.225	4.136	0.000	Large
H20	UT -> BI	0.274	0.086	3.189	0.001	Large
H16	ENJ -> PEOU	0.107	0.057	1.881	0.030	Large
H4	BI -> USE	0.039	0.026	1.496	0.067	Large
H11	RES -> PU	0.041	0.027	1.525	0.064	Large
H5	SN -> BI	0.048	0.035	1.376	0.084	Large
H13	PEC -> PEOU	0.072	0.043	1.684	0.046	Large
H1	PU -> BI	0.072	0.040	1.801	0.036	Large
H17	UI -> BI	0.018	0.025	0.705	0.240	Small
H22	UT -> PEOU	0.013	0.017	0.758	0.224	Small
H18	UI -> PU	0.015	0.015	1.055	0.146	Small
H19	UI -> PEOU	0.000	0.004	0.117	0.453	No Effect
H14	CANX -> PEOU	0.009	0.011	0.820	0.206	No Effect
H15	CPLAY -> PEOU	0.000	0.006	0.028	0.489	No Effect
H8	IMG -> PU	0.002	0.006	0.301	0.382	No Effect
H9	REL -> PU	0.000	0.007	0.013	0.495	No Effect
H2	PEOU -> BI	0.007	0.014	0.499	0.309	No Effect
H12	CSE -> PEOU	0.000	0.005	0.013	0.495	No Effect
H6	SN -> PU	0.000	0.006	0.076	0.470	No Effect
H21	UT -> PU	0.003	0.007	0.384	0.351	No Effect

6.9.2.4 Predictive Relevance (Q^2)

Ringle, Sinkovics and Henseler (2009) state that the blindfolding technique is implemented to test the study model of the predictive relevance. Q^2 assesses the validity of the prediction in huge complex model implementing PLS. This technique neglects data for a provided block of indictors to predict the neglected part according to the parameters calculation, that is while estimating parameters for a model under blindfolding procedure. Therefore, Q^2 indicates the collected empirical data degree and can be reconstructed with the assistance of model and the PLS parameters.

From the results presented in Table 6-15 and Figure 6-3, by an exclusion distance (D) of 7. This case study gets a Q^2 BI=0.534, IMG=0.349, PEOU=0.388, PU=0.598 and USE=0.029. According to Hair et al. (2011) that is regarded more than the cut-off value 0.0, thus indicating that model of the research in the current study has predictive relevance.

Table 6-15 Q-Square (CPR System)

	SSO	SSE	Q² (=1-SSE/SSO)
Behavioural Intention	843.000	393.149	0.534
Computer Anxiety	281.000	281.000	
Computer Playfulness	843.000	843.000	
Computer Self-Efficacy	1,124.000	1,124.000	
External Control	1,124.000	1,124.000	
Image	843.000	548.573	0.349
Job Relevance	562.000	562.000	
Perceived Ease of Use	1,405.000	860.166	0.388
Perceived Enjoyment	843.000	843.000	
Perceived Usefulness	1,405.000	564.439	0.598
Result Demonstrability	843.000	843.000	
Subjective Norm	843.000	843.000	
Use Behaviour	281.000	272.811	0.029
User Involvement	1,124.000	1,124.000	
User Training	1,405.000	1,405.000	

Note: Sum of Squared Observations (SSO) and Squared Predication Errors (SSE)

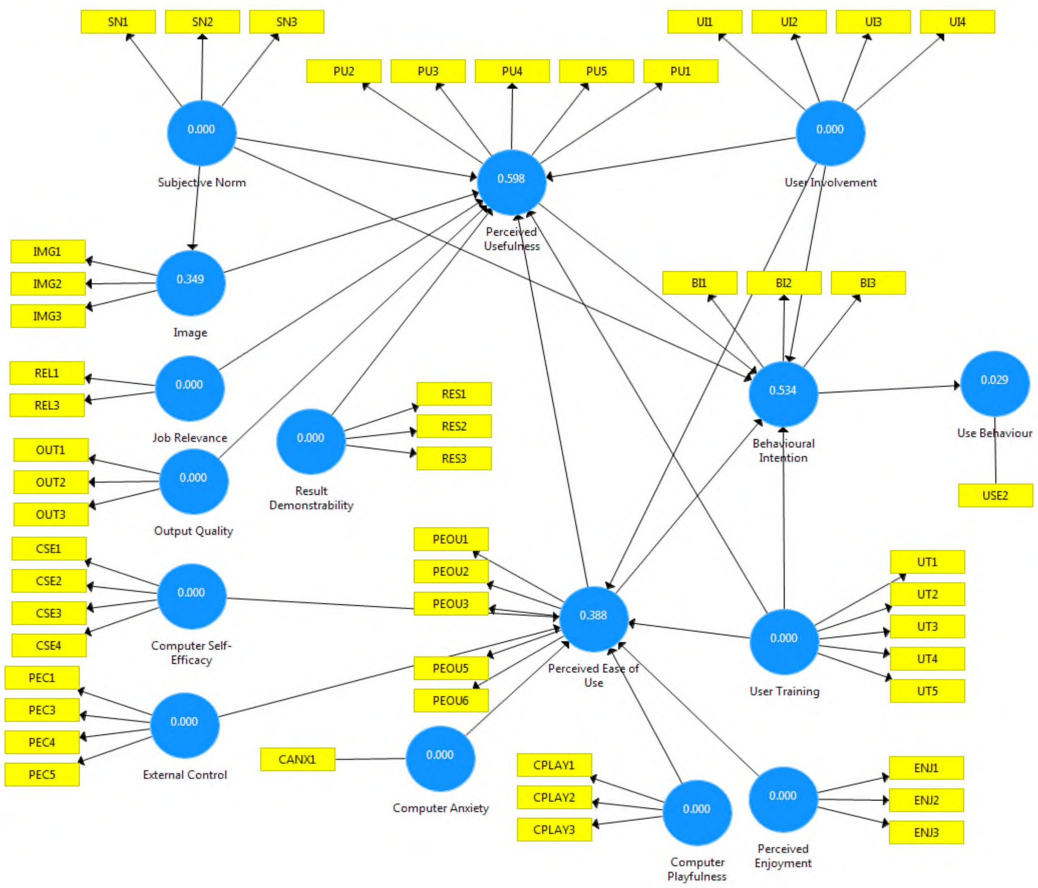


Figure 6-3 Bootstrapping Result from CRP System

6.9.2.5 Moderating Effects Assessment

For better understanding of the model structure, it is essential to consider its effect over the moderating variables. Through the literature review the two moderators are: experience, voluntariness. The rest of the moderators are extended from the 4 cases studies: education, nationality, gender and age. By referring to Table 6-16, it appears that there are no significant effects between all the moderating variables and HIS implementation success. Except EXP+CANX -> PEOU and EXP + ENJ -> PEOU is found to be significant.

Hence, a multi-group analysis is not conducted to assess the moderating effects because every group contained less than the minimum requirement of 90 samples. This is regarded as the minimum condition set for PLS analysis in the current study.

Table 6-16 Path Coefficient of the research hypotheses (CPR System)

H	Relation	Std. Beta	Std. Error	T-value	P-values	Decision
H23	**Education + SN -> BI**	-0.026	0.044	0.585	0.279	Not Supported
H24	**Nationality + SN -> BI**	0.015	0.056	0.265	0.396	Not Supported
H25	**Gender +SN -> BI**	-0.046	0.044	1.055	0.146	Not Supported
H26	**Age + SN -> BI**	-0.049	-0.049	-0.047	-0.049	Not Supported
H27	**VOL + SN -> BI**	-0.018	0.031	0.571	0.284	Not Supported
H28	**EXP + SN -> BI**	0.061	0.069	0.872	0.192	Not Supported
H28	**EXP + PEOU -> BI**	-0.034	0.078	0.433	0.333	Not Supported
H28	**EXP+CPLAY -> PEOU**	0.020	0.053	0.383	0.351	Not Supported
H28	**EXP+CANX -> PEOU**	-0.121	0.052	2.316	0.010	Supported
H28	**EXP + ENJ -> PEOU**	-0.099	0.048	2.044	0.021	Supported
H28	**EXP + PEOU -> PU**	0.022	0.058	0.379	0.352	Not Supported
H28	**EXP + SN -> PU**	-0.042	0.050	0.836	0.202	Not Supported

Figure 6-4 illustrates the final result from PLS-SEM analysis. The normal arrows represent the statistical significance of variables relationship. The dotted arrows illustrate the non-statistical significance of variables relationship. In the current study, the extension of TAM3 with user involvement and user training is 3 out of 6, that confirms the statistical significance. Meanwhile, all moderators like education, nationality, gender and age are not found to be statistical significance.

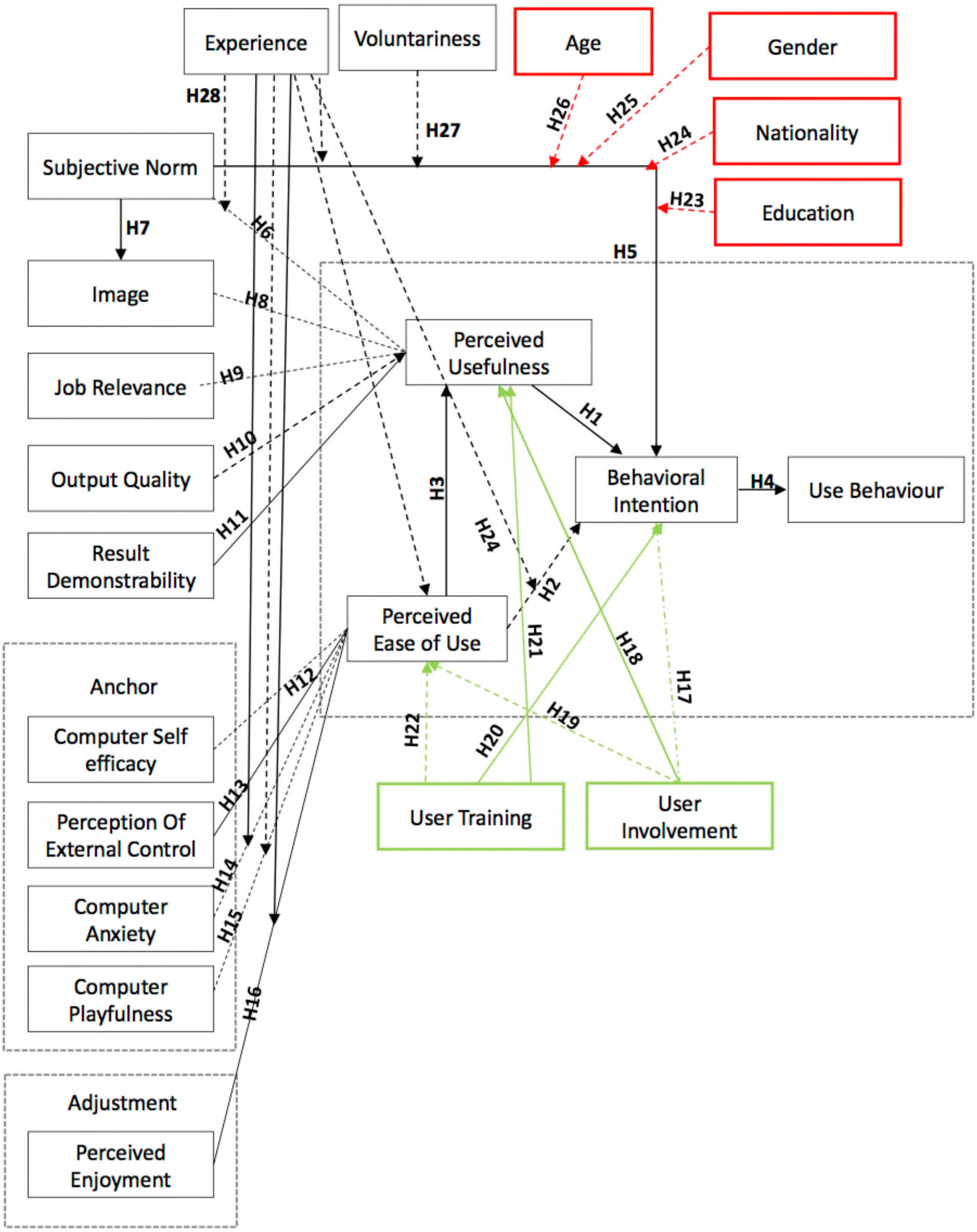


Figure 6-4 The final model for CPR system

6.10 Data Analysis for Nurtal Survey

To avoid repetition, only the short summary of the results are presented below:

6.10.1 Assessment of the Measurement Model

In evaluating the measurement model, two main analyses were performed: 1) convergent validity and 2) discriminant validity.

6.10.1.1 Convergent Validity

The item results reliability of convergent validity are shown in Table 6-17 and is illustrated in Figure 6-5. More than 50% of variance is regarded for the respective construct. Consequently, eleven measurement items (PEOU4, CANX1, CANX2, PEC1, PEC2, REL2, RES4, USE1, USE2, CPLAY3 and CPLAY4) are deleted after the initial operation. Table 6-17 reports the internal consistency results

Table 6-17 Reliability and Validity Assessment of the Model (Nurtal System)

Latent Variable	Indicators (item)	Loading	Cronbach Alpha	Composite Reliability	AVE
Perceived Usefulness	PU1	0.747	0.935	0.945	0.659
	PU2	0.792			
	PU3	0.750			
	PU4	0.796			
	PU5	0.862			
	PU6	0.843			
	PU7	0.820			
	PU8	0.825			
	PU9	0.859			
Perceived Ease of Use	PEOU1	0.862	0.843	0.889	0.590
	PEOU2	0.887			
	PEOU3	0.819			
	PEOU4	0.277			
	PEOU5	0.815			
	PEOU6	0.772			
Computer Anxiety	CANX1	0.643	0.849	0.001	0.175
	CANX2	0.140			
	CANX3	-0.325			
	CANX4	-0.404			
Perceived Enjoyment	ENJ1	0.918	0.918	0.948	0.859
	ENJ2	0.938			
	ENJ3	0.923			
Subjective Norm	SN1	0.825	0.873	0.913	0.724
	SN2	0.855			
	SN3	0.883			

	SN4	0.841			
Image	IMG1	0.833	0.790	0.877	0.704
	IMG2	0.865			
	IMG3	0.819			
Perceptions of External Control	PEC1	0.697	0.793	0.861	0.563
	PEC2	0.462			
	PEC3	0.842			
	PEC4	0.882			
	PEC5	0.791			
Job Relevance	REL1	0.857	0.705	0.803	0.520
	REL2	0.431			
	REL3	0.850			
	REL4	0.661			
Result Demonstrability	RES1	0.864	0.767	0.849	0.606
	RES2	0.892			
	RES3	0.874			
	RES4	0.344			
Behavioural Intention	BI1	0.929	0.909	0.943	0.846
	BI2	0.926			
	BI3	0.904			
Use Behaviour	USE1	0.469	0.080	0.601	0.341
	USE2	0.551			
	USE3	0.706			
Computer Self-Efficacy	CSE1	0.687	0.835	0.887	0.665
	CSE2	0.817			
	CSE3	0.856			
	CSE4	0.886			
Computer Playfulness	CPLAY1	0.887	0.662	0.767	0.518
	CPLAY2	0.924			
	CPLAY3	0.655			
	CPLAY4	0.054			
User Involvement	UI1	0.836	0.875	0.914	0.728
	UI2	0.879			
	UI3	0.882			
	UI4	0.813			
User Training	UT1	0.810	0.883	0.914	0.682
	UT2	0.801			
	UT3	0.833			
	UT4	0.847			
	UT5	0.836			

Table 6-18 Internal Consistency of the Model (Nurtal System)

	Cronbach's Alpha	Composite Reliability	AVE
Perceived Usefulness	0.935	0.945	0.658
Perceived Ease of Use	0.889	0.919	0.695
Computer Anxiety	0.882	0.944	0.894
Perceived Enjoyment	0.918	0.948	0.859
Subjective Norm	0.873	0.913	0.724
Image	0.790	0.877	0.704
Perceptions of External Control	0.850	0.909	0.769
Job Relevance	0.734	0.880	0.787
Result Demonstrability	0.853	0.911	0.773
Behavioural Intention	0.909	0.943	0.846
Use Behaviour	1.000	1.000	1.000
Computer Self-Efficacy	0.825	0.896	0.741
Computer Playfulness	0.838	0.925	0.861
User Involvement	0.875	0.914	0.728
User Training	0.883	0.915	0.682

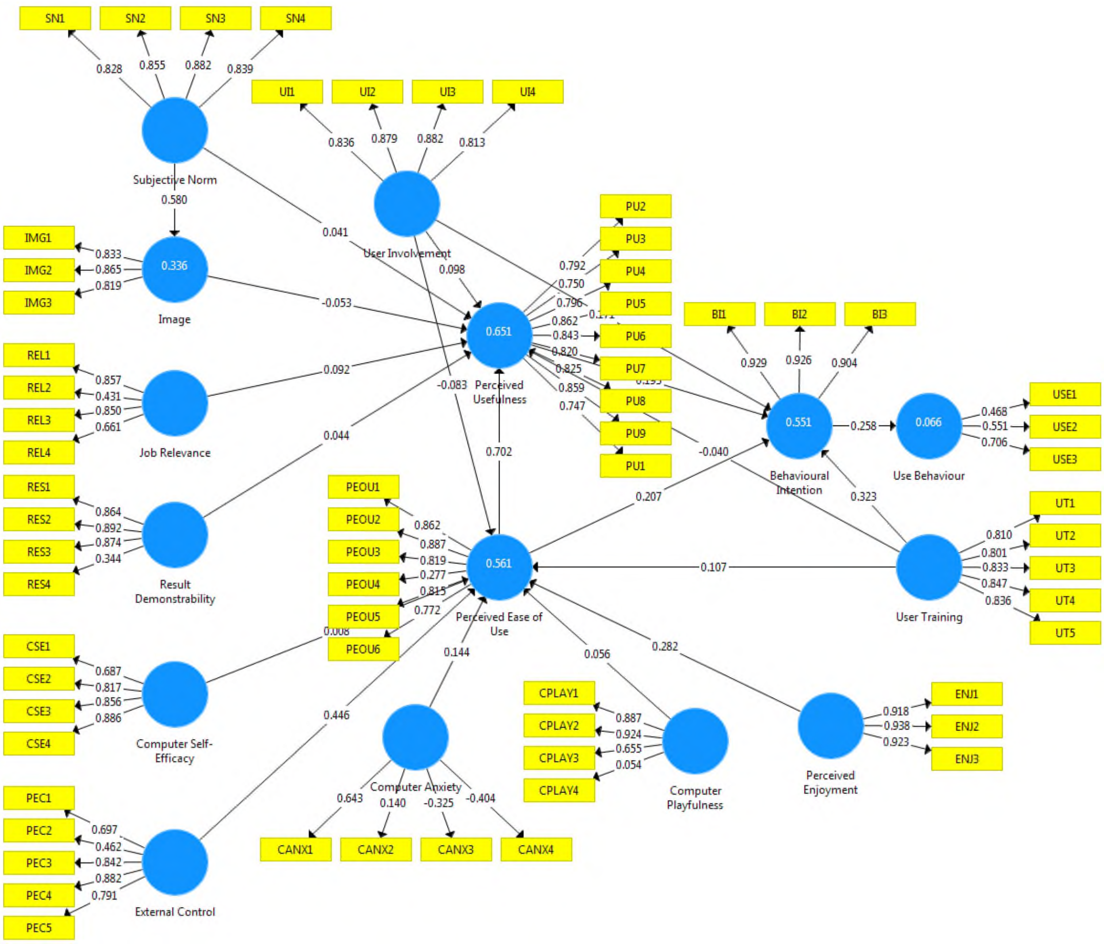


Figure 6-5 PLS Results of Initial Measurement (Nurtal System)

6.10.1.2 Discriminant Validity

The cross-loading results in Table 6-19 revealed that all items load higher on their respective constructs in comparison to their cross-loadings on the other constructs. This confirms that the measurement model has strong discriminant validity at the item level and meets the first discriminant validity norm.

The second assessment in discriminant analysis was to examine the AVE shared between a construct and its measures as Table 6-20. Therefore, the results demonstrate that the square root of AVE on the diagonal is greater than the off-diagonal elements across the row and down the column. Therefore, this finding indicates that the results are satisfactory and confirms the establishment of the discriminant validity at the construct level.

Table 6-19 Cross-Loadings of Items (Nurtal System)

	BI	CANX	CPLAY	CSE	ENJ	IMG	PEC	PEOU	PU	REL	RES	SN	USE	UI	UT
BI1	**0.929**	-0.077	0.449	0.278	0.631	0.574	0.598	0.538	0.522	0.535	0.665	0.575	0.140	0.531	0.612
BI2	**0.926**	-0.094	0.446	0.261	0.628	0.528	0.563	0.569	0.519	0.513	0.657	0.565	0.142	0.482	0.584
BI3	**0.904**	-0.103	0.441	0.214	0.630	0.587	0.586	0.600	0.580	0.578	0.659	0.602	0.249	0.553	0.614
CANX3	-0.093	**0.945**	-0.086	0.021	-0.110	-0.022	-0.018	-0.106	0.046	-0.030	0.046	-0.202	-0.143	0.095	-0.027
CANX4	-0.096	**0.947**	-0.085	-0.005	-0.127	-0.048	-0.056	-0.107	0.082	-0.064	0.046	-0.189	-0.180	0.062	-0.047
CPLAY1	0.464	-0.148	**0.933**	0.330	0.467	0.388	0.422	0.441	0.399	0.402	0.413	0.376	0.186	0.313	0.452
CPLAY2	0.434	-0.016	**0.922**	0.337	0.423	0.400	0.440	0.411	0.426	0.365	0.509	0.327	0.188	0.355	0.466
CSE2	0.203	0.015	0.316	**0.805**	0.161	0.113	0.241	0.179	0.161	0.125	0.189	0.126	-0.009	0.125	0.195
CSE3	0.274	0.002	0.323	**0.885**	0.238	0.230	0.247	0.215	0.184	0.196	0.256	0.233	0.012	0.160	0.265
CSE4	0.219	0.006	0.289	**0.891**	0.182	0.213	0.199	0.192	0.162	0.166	0.203	0.186	-0.014	0.146	0.213
ENJ1	0.542	0.054	0.406	0.191	**0.474**	0.420	0.435	0.520	0.919	0.490	0.544	0.457	0.239	0.492	0.540
ENJ2	0.551	0.037	0.430	0.184	**0.515**	0.431	0.474	0.576	0.938	0.578	0.564	0.481	0.249	0.482	0.536
ENJ3	0.545	0.098	0.397	0.172	**0.500**	0.424	0.411	0.548	0.923	0.541	0.562	0.460	0.218	0.534	0.541
IMG1	0.493	-0.101	0.393	0.255	0.529	**0.833**	0.475	0.468	0.388	0.381	0.501	0.520	0.134	0.354	0.519
IMG2	0.518	-0.008	0.342	0.159	0.516	**0.865**	0.459	0.428	0.367	0.346	0.516	0.468	0.117	0.438	0.523
IMG3	0.534	0.021	0.330	0.132	0.522	**0.819**	0.465	0.443	0.397	0.402	0.543	0.467	0.129	0.462	0.496
PEC3	0.570	-0.149	0.370	0.214	0.867	0.525	**0.506**	0.574	0.453	0.470	0.551	0.506	0.158	0.385	0.542
PEC4	0.644	-0.117	0.447	0.190	0.920	0.571	**0.621**	0.631	0.501	0.555	0.627	0.517	0.187	0.437	0.612
PEC5	0.587	-0.059	0.450	0.197	0.843	0.546	**0.641**	0.508	0.454	0.448	0.587	0.470	0.148	0.480	0.551
PEOU1	0.536	-0.125	0.359	0.183	0.571	0.429	0.512	**0.864**	0.457	0.723	0.561	0.544	0.166	0.313	0.460
PEOU2	0.564	-0.148	0.408	0.199	0.574	0.473	0.523	**0.893**	0.509	0.726	0.583	0.582	0.215	0.355	0.484
PEOU3	0.475	-0.120	0.378	0.187	0.515	0.452	0.402	**0.821**	0.484	0.629	0.546	0.504	0.195	0.330	0.426
PEOU5	0.522	-0.089	0.391	0.172	0.549	0.410	0.476	**0.814**	0.507	0.665	0.490	0.504	0.175	0.343	0.484
PEOU6	0.480	0.029	0.383	0.211	0.514	0.463	0.376	**0.770**	0.518	0.547	0.538	0.453	0.136	0.413	0.507
PU2	0.437	-0.010	0.269	0.149	0.365	0.302	0.357	0.525	**0.458**	0.792	0.424	0.424	0.259	0.323	0.314

PU3	0.392	0.030	0.239	0.139	0.321	0.233	0.344	0.485	**0.444**	0.750	0.391	0.360	0.266	0.271	0.255
PU4	0.399	-0.068	0.282	0.114	0.412	0.298	0.387	0.581	**0.440**	0.796	0.428	0.429	0.217	0.301	0.343
PU5	0.575	-0.097	0.407	0.168	0.557	0.453	0.458	0.718	**0.524**	0.862	0.531	0.483	0.250	0.417	0.499
PU6	0.504	-0.058	0.380	0.151	0.499	0.427	0.440	0.705	**0.457**	0.843	0.496	0.463	0.233	0.374	0.476
PU7	0.429	-0.029	0.293	0.139	0.445	0.362	0.428	0.653	**0.452**	0.820	0.472	0.404	0.208	0.315	0.387
PU8	0.531	-0.036	0.385	0.158	0.496	0.378	0.485	0.719	**0.442**	0.825	0.517	0.468	0.180	0.308	0.426
PU9	0.551	-0.097	0.370	0.193	0.520	0.418	0.482	0.759	**0.517**	0.859	0.541	0.479	0.232	0.387	0.461
REL1	0.632	-0.138	0.444	0.249	0.689	0.527	0.921	0.561	0.456	**0.523**	0.609	0.575	0.167	0.412	0.535
REL3	0.475	0.103	0.374	0.222	0.472	0.454	0.852	0.401	0.380	**0.389**	0.519	0.424	0.066	0.410	0.463
RES1	0.589	0.042	0.456	0.212	0.603	0.531	0.542	0.572	0.509	0.502	**0.866**	0.478	0.200	0.503	0.568
RES2	0.671	0.090	0.424	0.193	0.570	0.574	0.577	0.558	0.549	0.502	**0.894**	0.529	0.190	0.535	0.575
RES3	0.634	0.000	0.426	0.259	0.596	0.531	0.569	0.589	0.527	0.542	**0.877**	0.485	0.196	0.510	0.600
SN1	0.519	-0.229	0.308	0.118	0.490	0.507	0.499	0.518	0.433	0.467	0.431	**0.828**	0.155	0.342	0.445
SN2	0.524	-0.132	0.270	0.158	0.443	0.478	0.452	0.515	0.437	0.441	0.499	**0.855**	0.156	0.351	0.448
SN3	0.539	-0.169	0.337	0.227	0.480	0.498	0.523	0.537	0.423	0.435	0.495	**0.882**	0.157	0.361	0.478
SN4	0.568	-0.171	0.376	0.226	0.517	0.489	0.473	0.549	0.420	0.492	0.500	**0.839**	0.191	0.372	0.466
USE3	0.195	-0.171	0.201	-0.004	0.189	0.151	0.139	0.214	0.254	0.276	0.222	0.194	**1.000**	0.137	0.155
UI1	0.514	0.096	0.325	0.149	0.457	0.445	0.419	0.361	0.455	0.344	0.524	0.352	0.107	**0.836**	0.566
UI2	0.535	0.022	0.325	0.122	0.467	0.478	0.455	0.403	0.497	0.415	0.568	0.421	0.165	**0.879**	0.627
UI3	0.489	0.067	0.328	0.176	0.425	0.400	0.378	0.370	0.467	0.366	0.477	0.354	0.064	**0.881**	0.645
UI4	0.384	0.110	0.233	0.126	0.305	0.359	0.302	0.277	0.426	0.321	0.416	0.286	0.129	**0.813**	0.589
UT1	0.503	0.079	0.327	0.193	0.459	0.453	0.460	0.414	0.495	0.400	0.510	0.392	0.137	0.644	**0.810**
UT2	0.598	-0.087	0.402	0.190	0.556	0.519	0.435	0.523	0.450	0.438	0.547	0.476	0.116	0.599	**0.801**
UT3	0.579	-0.072	0.425	0.209	0.558	0.519	0.493	0.485	0.518	0.450	0.566	0.486	0.166	0.591	**0.833**
UT4	0.486	-0.029	0.424	0.253	0.523	0.531	0.457	0.435	0.453	0.363	0.525	0.441	0.103	0.547	**0.847**
UT5	0.527	-0.036	0.455	0.246	0.572	0.494	0.487	0.464	0.481	0.391	0.576	0.423	0.115	0.550	**0.836**

Table 6-20 Latent Variable Constructs (Nurtal System)

	BI	CANX	CPLAY	CSE	PEC	IMG	REL	PEOU	ENJ	PU	RES	SN	USE	UI	UT
BI	**0.920**														
CANX	-0.100	**0.946**													
CPLAY	0.485	-0.091	**0.928**												
CSE	0.272	0.008	0.359	**0.861**											
PEC	0.685	-0.126	0.480	0.227	**0.877**										
IMG	0.614	-0.037	0.425	0.219	0.623	**0.839**									
REL	0.634	-0.039	0.464	0.266	0.669	0.556	**0.887**								
PEOU	0.620	-0.113	0.460	0.228	0.655	0.533	0.553	**0.833**							
ENJ	0.589	0.068	0.444	0.197	0.536	0.459	0.476	0.592	**0.927**						
PU	0.591	-0.050	0.414	0.191	0.563	0.450	0.523	0.793	0.580	**0.811**					
RES	0.718	0.049	0.495	0.253	0.671	0.620	0.640	0.652	0.601	0.587	**0.879**				
SN	0.632	-0.207	0.380	0.214	0.568	0.580	0.573	0.623	0.503	0.540	0.565	**0.851**			
USE	0.195	-0.171	0.201	-0.004	0.189	0.151	0.139	0.214	0.254	0.276	0.222	0.194	**1.000**		
UI	0.569	0.083	0.359	0.168	0.492	0.497	0.462	0.419	0.542	0.427	0.587	0.419	0.137	**0.853**	
UT	0.657	-0.039	0.494	0.263	0.649	0.611	0.566	0.566	0.581	0.498	0.662	0.540	0.155	0.711	**0.826**

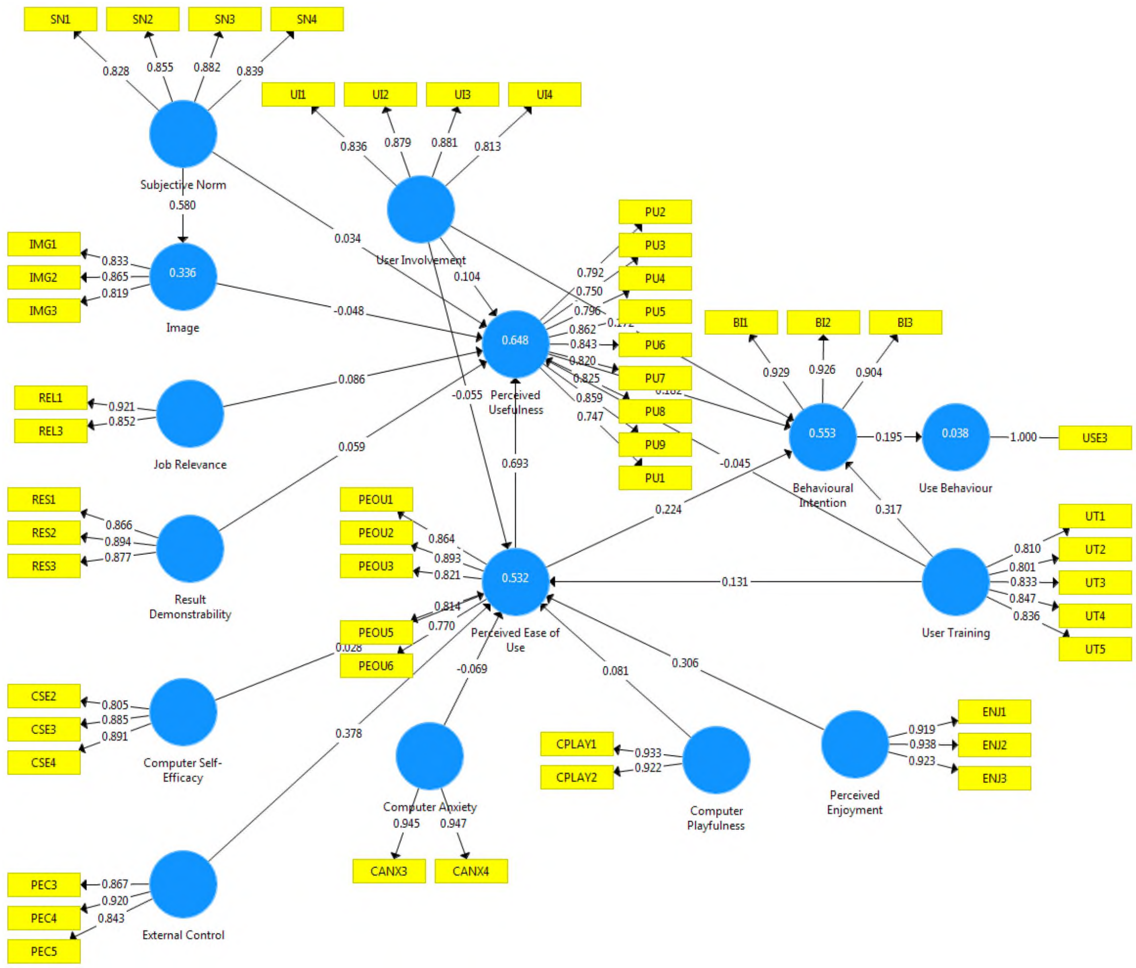


Figure 6-6 PLS Results of Final Measurement (Nurtal System)

6.10.2 Assessment of the Structural Model

The structural model comprises the hypothesized relationship between the latent constructs. To assess the structural model, the following analyses are calculated: Coefficients of determination (R^2), path coefficient (hypotheses testing), predictive relevance (q^2) and f^2 effect sizes.

6.10.2.1 Coefficients of Determination (R^2)

In Table 6-21 the results are extracted into the structural model. The R^2 value is interpreted as a manner of regression. Thus, the exogenous constructs results explain 33.6% of the variance in image which is the central endogenous construct for the model.

Table 6-21 R-Square of the Endogenous Latent Variables (Nurtal System)

R^2 Values for the Main Model	R Square	Result
Behavioural Intention	0.594	Moderate
Image	0.336	Moderate
Perceived Ease of Use	0.532	Moderate
Perceived Usefulness	0.648	High
Use Behaviour	0.038	Weak

6.10.2.2 Path Coefficient (Hypotheses Testing)

Table 6-22 presents the results of the hypotheses (path coefficient). The findings show that half of hypotheses (10 out of 21) was supported in the study. PU, SN and UT were found to be strongly statistically significant in explaining behavioural intention, $p<0.000$, supporting hypotheses **H1**, **H5** and **H20**. In the opposite situation is PEOU, which are not statistically significant, not supporting hypotheses **H2**.

Table 6-22 Path Coefficient of the research hypotheses (Nurtal System)

H	Relation	Std. Beta	Std. Error	T-value	P-values	Decision
H19	**UI -> BI**	0.160	0.059	2.725	0.006	Supported
H2	**PEOU -> BI**	0.114	0.060	1.902	0.057	Not Supported
H1	**PU -> BI**	0.160	0.053	3.020	0.003	Supported
H20	**UT -> BI**	0.253	0.061	4.112	0.000	Supported
H5	**SN -> BI**	0.271	0.055	4.945	0.000	Supported
H6	**SN -> PU**	0.033	0.049	0.686	0.493	Not Supported
H8	**IMG -> PU**	-0.048	0.047	1.025	0.305	Not Supported
H21	**UT -> PU**	-0.045	0.047	0.968	0.333	Not Supported
H9	**REL -> PU**	0.087	0.047	1.826	0.068	Not Supported
H11	**RES -> PU**	0.059	0.061	0.972	0.331	Not Supported
H18	**UI -> PU**	0.104	0.054	1.937	0.053	Not Supported
H3	**PEOU -> PU**	0.693	0.044	15.777	0.000	Supported
H14	**CANX -> PEOU**	-0.069	0.033	2.070	0.038	Supported
H15	**CPLAY -> PEOU**	0.081	0.045	1.787	0.074	Not Supported
H22	**UT -> PEOU**	0.131	0.062	2.136	0.033	Supported
H17	**UI -> PEOU**	-0.055	0.055	0.995	0.320	Not Supported
H12	**CSE -> PEOU**	0.028	0.035	0.786	0.432	Not Supported
H13	**PEC -> PEOU**	0.378	0.056	6.698	0.000	Supported
H16	**ENJ -> PEOU**	0.306	0.052	5.830	0.000	Supported

H7	**SN -> IMG**	0.579	0.044	13.106	0.000	Supported
H4	**BI -> USE**	0.195	0.048	4.072	0.000	Supported

Note: Significant *$p<0.05$, **$p<0.01$, ***$p<0.001$

6.10.2.3 f^2 Effect Sizes

In Table 6-23, only 7 out of 21 relations have large effect. The largest relation is H7 **PEOU -> PU.** 12 out of 21 F^2 have the majority of small effect size for example **CANX -> PEOU.** Finally, no F^2 is found with no effect **CANX -> PEOU.**

Table 6-23 : F-Square effect sizes (Nurtal System)

H	Relation	Std. Beta	Std. Error	T-value	P-values	Result
H7	**SN -> IMG**	**0.505**	0.121	4.187	0.000	Large
H3	**PEOU -> PU**	**0.631**	0.118	5.331	0.000	Large
H21	**UT -> PU**	**0.061**	0.031	1.998	0.046	Large
H13	**PEC -> PEOU**	**0.155**	0.053	2.940	0.003	Large
H16	**ENJ -> PEOU**	**0.112**	0.041	2.716	0.007	Large
H4	**BI -> USE**	**0.039**	0.021	1.883	0.060	Large
H5	**SN -> BI**	**0.101**	0.044	2.289	0.022	Large
H17	**UI -> BI**	0.030	0.024	1.265	0.206	Medium
H1	**PU -> BI**	0.023	0.016	1.443	0.149	Medium
H19	**UI -> PEOU**	**0.013**	0.013	1.006	0.315	Small
H14	**CANX -> PEOU**	**0.009**	0.010	0.966	0.334	Small
H15	**CPLAY -> PEOU**	**0.009**	0.011	0.841	0.401	Small
H12	**CSE -> PEOU**	**0.001**	0.005	0.268	0.789	Small
H22	**UT -> PEOU**	**0.002**	0.005	0.384	0.701	Small
H11	**RES -> PU**	**0.004**	0.009	0.392	0.695	Small
H9	**REL -> PU**	**0.011**	0.013	0.844	0.399	Small
H18	**UI -> PU**	**0.014**	0.017	0.851	0.395	Small
H8	**IMG -> PU**	**0.003**	0.008	0.423	0.672	Small
H6	**SN -> PU**	**0.002**	0.007	0.230	0.818	Small
H20	**UT -> BI**	**0.013**	0.013	1.006	0.315	Small
H2	**PEOU -> BI**	**0.010**	0.011	0.860	0.390	Small

6.10.2.4 Predictive Relevance (q^2)

From the results presented in Table 6-24 and Figure 6-7, by an exclusion distance (D) of 7. This case study gets a Q^2 BI=0.470, IMG=0.221, PEOU=0.342, PU=0.390 and USE=0.034. According to Hair et al. (2011) that is regarded more than the cut-off value 0.0, thus indicating that model of the research in the current study has predictive relevance.

Table 6-24 Q-Square (Nurtal System)

	SSO	SSE	Q² (=1-SSE/SSO)
Behavioural Intention	1,413.000	749.381	0.470
Computer Anxiety	942.000	942.000	
Computer Playfulness	942.000	942.000	
Computer Self-Efficacy	1,413.000	1,413.000	
External Control	1,413.000	1,413.000	
Image	1,413.000	1,100.198	0.221
Job Relevance	942.000	942.000	
Perceived Ease of Use	2,355.000	1,549.683	0.342
Perceived Enjoyment	1,413.000	1,413.000	
Perceived Usefulness	4,239.000	2,583.689	0.390
Result Demonstrability	1,413.000	1,413.000	
Subjective Norm	1,884.000	1,884.000	
Use Behaviour	471.000	455.218	0.034
User Involvement	1,884.000	1,884.000	
User Training	2,355.000	2,355.000	

Note: Sum of Squared Observations (SSO) and Squared Predication Errors (SSE)

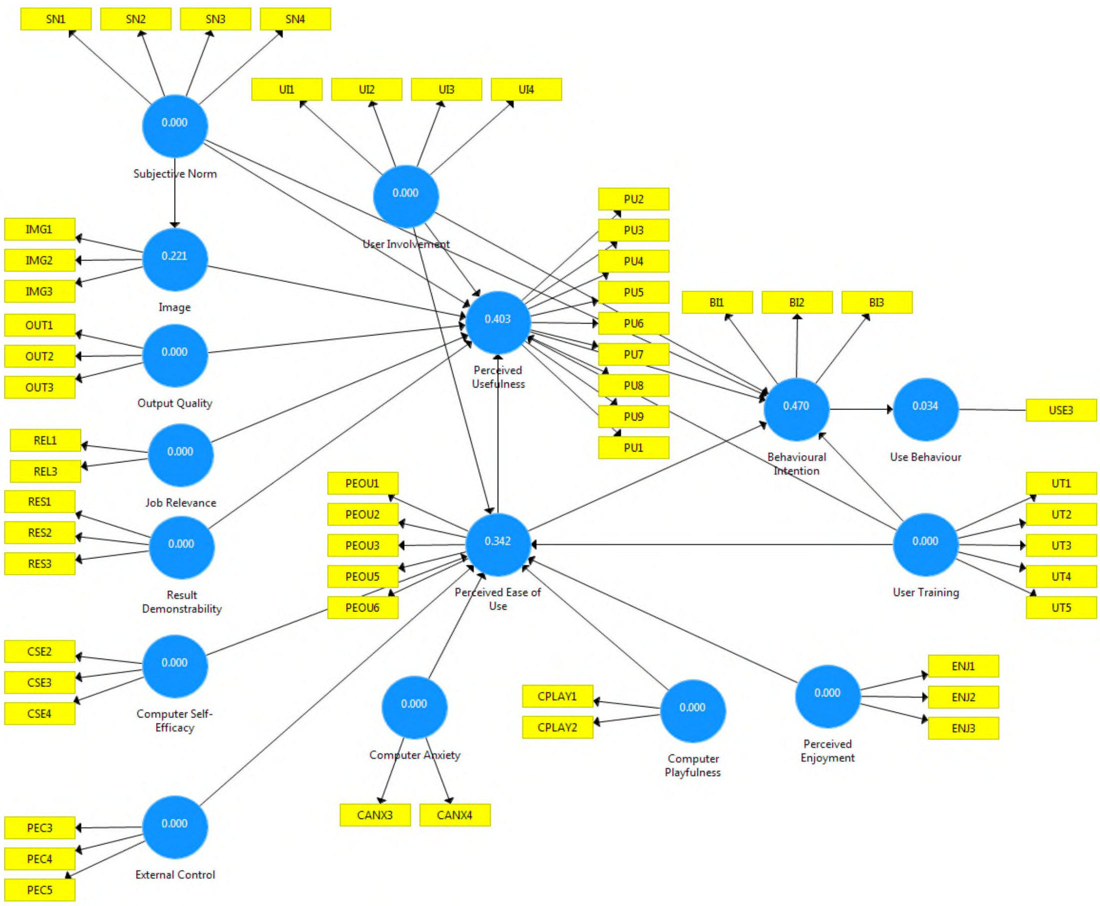


Figure 6-7 Bootstrapping Result from Nurtal System

6.10.2.5 Moderating Effects Assessment

Similar to the CPR system analysis there are no statistically significance for the two moderators: experience, voluntariness, and the rest of moderators which are extended from the 4 cases studies: education nationality, gender and age. By referring to Table 6-25, it appears that there are no significant effects between all the moderating variables and HIS implementation success.

Hence, a multi-group analysis is not conducted to assess the moderating effects because every group contained less 90 samples, the minimum required. This is regarded as the minimum condition set for PLS analysis in the current study

Table 6-25 Path Coefficient of the research hypotheses (CPR System)

H	Relation	Std. Beta	Std. Error	T-value	P-values	Decision
H23	**Education + SN -> BI**	-0.021	0.054	0.395	0.693	Not Supported
H24	**Nationality + SN -> BI**	-0.032	0.038	0.847	0.397	Not Supported
H25	**Gender +SN -> BI**	-0.028	0.036	0.785	0.433	Not Supported
H26	**Age + SN -> BI**	-0.037	0.041	0.906	0.365	Not Supported
H27	**VOL + SN -> BI**	-0.034	0.036	0.933	0.351	Not Supported
H28	**EXP + SN -> BI**	0.087	0.056	1.555	0.120	Not Supported
H28	**EXP + PEOU -> BI**	-0.039	0.046	0.838	0.402	Not Supported
H28	**EXP+CPLAY -> PEOU**	0.019	0.044	0.419	0.675	Not Supported
H28	**EXP+CANX -> PEOU**	-0.036	0.049	0.730	0.466	Not Supported
H28	**EXP + ENJ -> PEOU**	-0.082	0.068	1.202	0.230	Not Supported
H28	**EXP + PEOU -> PU**	0.016	0.057	0.273	0.785	Not Supported
H28	**EXP + SN -> PU**	-0.005	0.047	0.116	0.907	Not Supported

Figure 6-8 illustrates the final result from PLS-SEM analysis. The normal arrows represent the statistical significance of variables relationship, in contrast, the dotted arrows illustrate the non-statistical significance of variables relationship. In the current study, the extension of TAM3 with user involvement and user training is 3 out of 6, that confirms the statistical significance. Meanwhile, all moderator as education, nationality, gender and age are not found statistical significance.

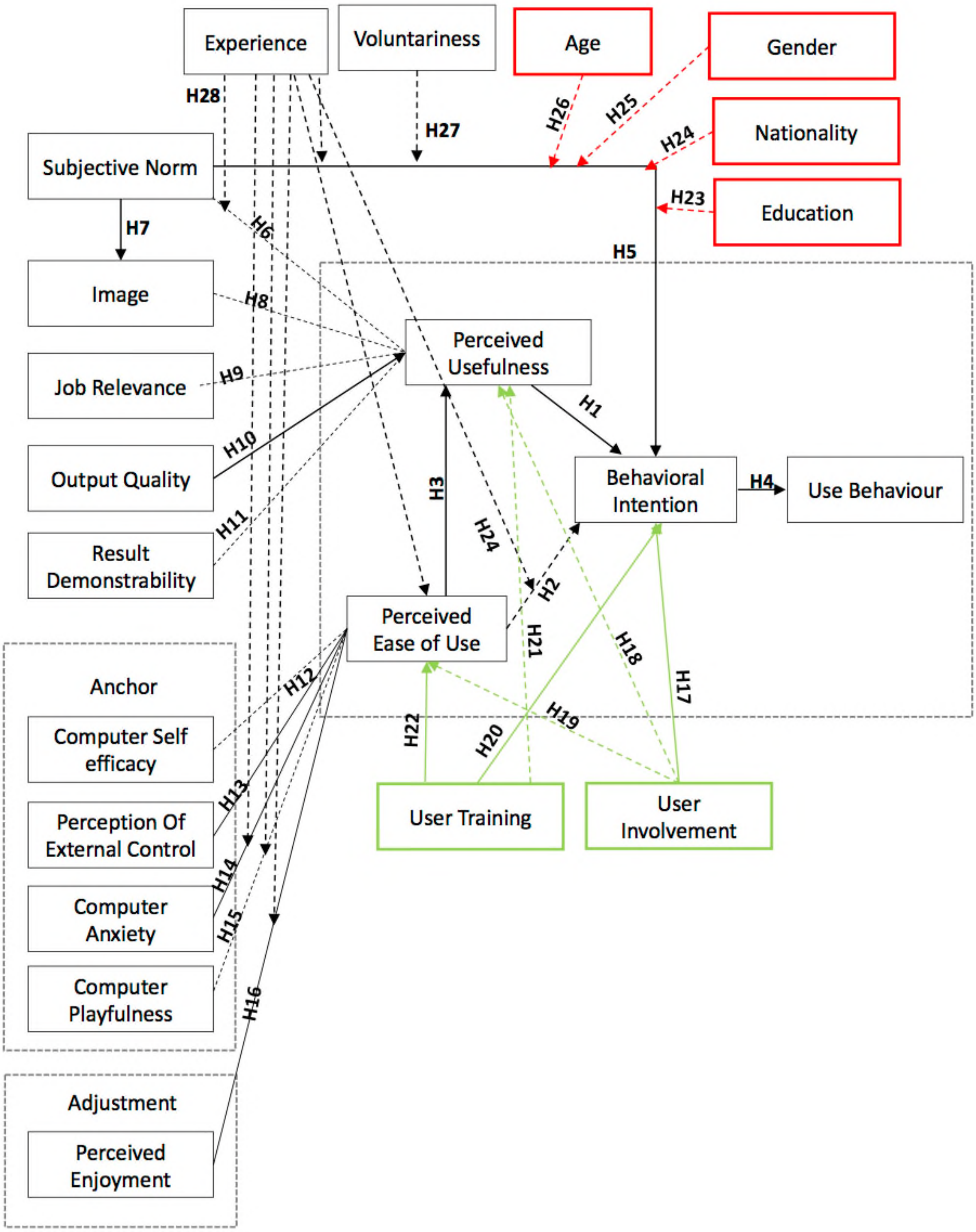


Figure 6-8 The final model of Nurtal system

7 Discussion and Conclusion

7.1 Introduction

In this chapter, the discussion is a combination from all data analysis and results conducted in the four studies in Chapter 4, 5 and 6. The first section begins by comparing the CPR and Nurtal systems analysis of the testing of hypotheses results and linking it with the previous studies. Afterwards, the critical factors are identified and challenges are classified in order to assist decision making during the implementation and the adoption process.

The conclusion section summarises the theoretical and practical research contributions, limitations of study and overview of potential future work.

7.2 The TAM3 Model Findings

7.2.1 Compare CPR and Nurtal

The perceived ease of use and perceived usefulness relationship are analysed. The most critical factors in the recent study are behavioural intention [exogenous constructs] and use behavioural [endogenous construct] because they answer the main objective of this research; the crucial factors that affect the HIT adoption among nurses. According to the findings, nearly eleven out twenty-two factors are found significant in the Saudi context; the findings that can be explained by cultures, various work attitude, work process and policies.

Computer anxiety is not statistically significant perhaps because the nurses are familiar with computers. In order to develop HIT use in healthcare organisation, it is necessary that the management work in improving positive organisational culture and encourage the paradigm shift among the health care providers. For instance, open communication should be supported by the management among all the organisation’s employees. In case of extreme high power distance, this can hinder the freedom to give feedback about the system or report medication errors without any threats of blame and punishment. Thus, HIT development cannot be reasonable when employees are worried about expressing their thoughts about the system or any other matters.

Another effective factor that is not supported is user involvement and perceived usefulness which is probably is a result of low nurses involvement through HIT implementation in compared with pharmacists. Accordingly, HIT complexity leads to over dependent on IT support as they do not want to be blamed if anything goes wrong. Thus, IT experts must be monitored by management, in order to spread knowledge and train among nurses.

Table 7-1 Comparison between CPR system and Nurtal system

<table>
<tr><th></th><th>CPR System</th><th>Nurtal System</th></tr>
<tr><td>Common factor</td><td colspan="2">Available on nurses’ intranet and it is able to access at any time in any ward
Leads to Achieve a very high level from automation
Reduces the percentage of medication errors
Increases the speed of work and improve the quality</td></tr>
<tr><td rowspan="3">Unique factor</td><td>Basic calculator</td><td>More complex</td></tr>
<tr><td>Combined CPOE with CDSS to validate the calculation</td><td>Basic communication does not reach the level of e-prescribing</td></tr>
<tr><td>The final calculation result has to be printed and not saved in the patient profile and it is kept as “hardcopy paper”</td><td>All the communication recorded electronically with unique number.</td></tr>
<tr><td></td><td>No records or tracking.</td><td>The medication status can be tracked in the system also the hardcopy can be tracked between the pharmacy and the ward.</td></tr>
</table>

7.2.2 Compare Model with Literature

The extended TAM3 model of this research was carefully examined to identify the factor effects of its concepts on the acceptance and use of HIT among nurses in tertiary hospital. The final results of extended TAM3 model are as follows.

Many hypotheses were produced regarding HIS adoption success and tested by PLS path coefficient analyses. In addition, the *t*-values and *p*-values are calculated. The results are found to be consistent with previous studies except for the relation to subjective norm image on perceived usefulness, computer self-efficacy, computer playfulness, and perceived ease of use. The results of the hypotheses with prior studies are compared on Table 7-2. It is necessary to highlight that the adoption definition and measurements applied in previous studies can diverge from those in this study.

Furthermore, the investigation of the moderating effect in the TAM3 model shows that all moderation has no significant influence on the model except experience. In fact, for the moderated effect of computer anxiety, perceived enjoyment (CANX × EXP) and (ENJ × EXP) and perceived ease of use, all these factors are increased by experience.

Only 14 hypotheses out of 22 were supported, while others required sufficient statistical evidence to be recognised. Below, the seven success factors are presented to clarify 65.6% of the variances in TAM3 model. Accordingly, such results powerfully suggest that the model has considerable explanatory influence in behavioural intention that will predict user acceptance.

Table 7-2 Direct hypotheses testing results compared with original TAM3 model

	Relation	**H**	**Affected Construct**	**Current Study**	**Original Study**
Sig both system	**PU -> BI**	**H1**	BI	Supported	Supported
	UT -> BI	**H20**			-
	SN -> BI	**H5**			Supported
	PEOU -> PU	**H3**	PU		Supported
	PEC -> PEOU	**H13**	PEOU		Supported
	ENJ -> PEOU	**H16**			(2 out 3) Supported
	SN -> IMG	**H7**	IMG		O/S:
	BI -> USE	**H4**	USE		Supported
Not Sig both system	**UI -> BI**	**H19**	BI	Not Supported	-
	PEOU -> BI	**H2**			(2 out 3) Supported
	SN -> PU	**H6**	PU		Supported
	IMG -> PU	**H8**			Supported
	UT -> PU	**H21**			-
	REL -> PU	**H9**			Not Supported
	UI -> PEOU	**H17**	PEOU		-
	CSE -> PEOU	**H12**			Supported
	CPLAY -> PEOU	**H15**			Supported
	Relation	**H**	**CPE System**	**N/P System**	**Prior Study**
Different	**RES -> PU**	**H11**	Sig	Not Supported	Supported
	UI -> PU	**H18**	Sig	Not Supported	-
	CANX -> PEOU	**H14**	Not Sig	Supported	Supported
	UT -> PEOU	**H22**	Not Sig	Supported	-
	Out-> PU	**H10**	Not Sig	Supported	Not Supported

Note: Venkatesh and Bala (2008): TAM3 Model = original study

Table 7-3 Moderating hypotheses testing results compared with original TAM3 model

<table>
<tr><th></th><th>Relation</th><th colspan="2">H</th><th>Current Study</th><th>Original study</th></tr>
<tr><td rowspan="10">Not Sig both system</td><td>Education + SN -> BI</td><td colspan="2">H23</td><td rowspan="10">Not Supported</td><td>-</td></tr>
<tr><td>Nationality + SN -> BI</td><td colspan="2">H24</td><td>-</td></tr>
<tr><td>Gender + SN -> BI</td><td colspan="2">H25</td><td>-</td></tr>
<tr><td>Age + SN -> BI</td><td colspan="2">H26</td><td>-</td></tr>
<tr><td>VOL + SN -> BI</td><td colspan="2">H27</td><td>Supported</td></tr>
<tr><td>EXP + SN -> BI</td><td colspan="2">H28</td><td>Supported</td></tr>
<tr><td>EXP + PEOU -> BI</td><td colspan="2">H28</td><td>Supported</td></tr>
<tr><td>EXP+CPLAY -> PEOU</td><td colspan="2">H28</td><td>Not Supported</td></tr>
<tr><td>EXP + PEOU -> PU</td><td colspan="2">H28</td><td>Supported</td></tr>
<tr><td>EXP + SN -> PU</td><td colspan="2">H28</td><td>Supported</td></tr>
<tr><th></th><th>Relation</th><th>H</th><th>CPR System</th><th>N/P System</th><th>Prior Study</th></tr>
<tr><td rowspan="2">Different</td><td>EXP+CANX -> PEOU</td><td>H28</td><td rowspan="2">Supported</td><td rowspan="2">Not Supported</td><td>Supported</td></tr>
<tr><td>EXP + ENJ -> PEOU</td><td>H28</td><td>Not Supported</td></tr>
</table>

Note: Venkatesh and Bala (2008): TAM3 Model = original study

Figure 7-1 illustrates the final research outcomes model of this study “Nursing Acceptance Model”. The evidence shows that only two constructs are found to show a statistically significant influence on the acceptance of Health Information Technology (HIT) among nurses at Saudi hospitals. Top management and leaders should pay more attention to user training and user involvement.

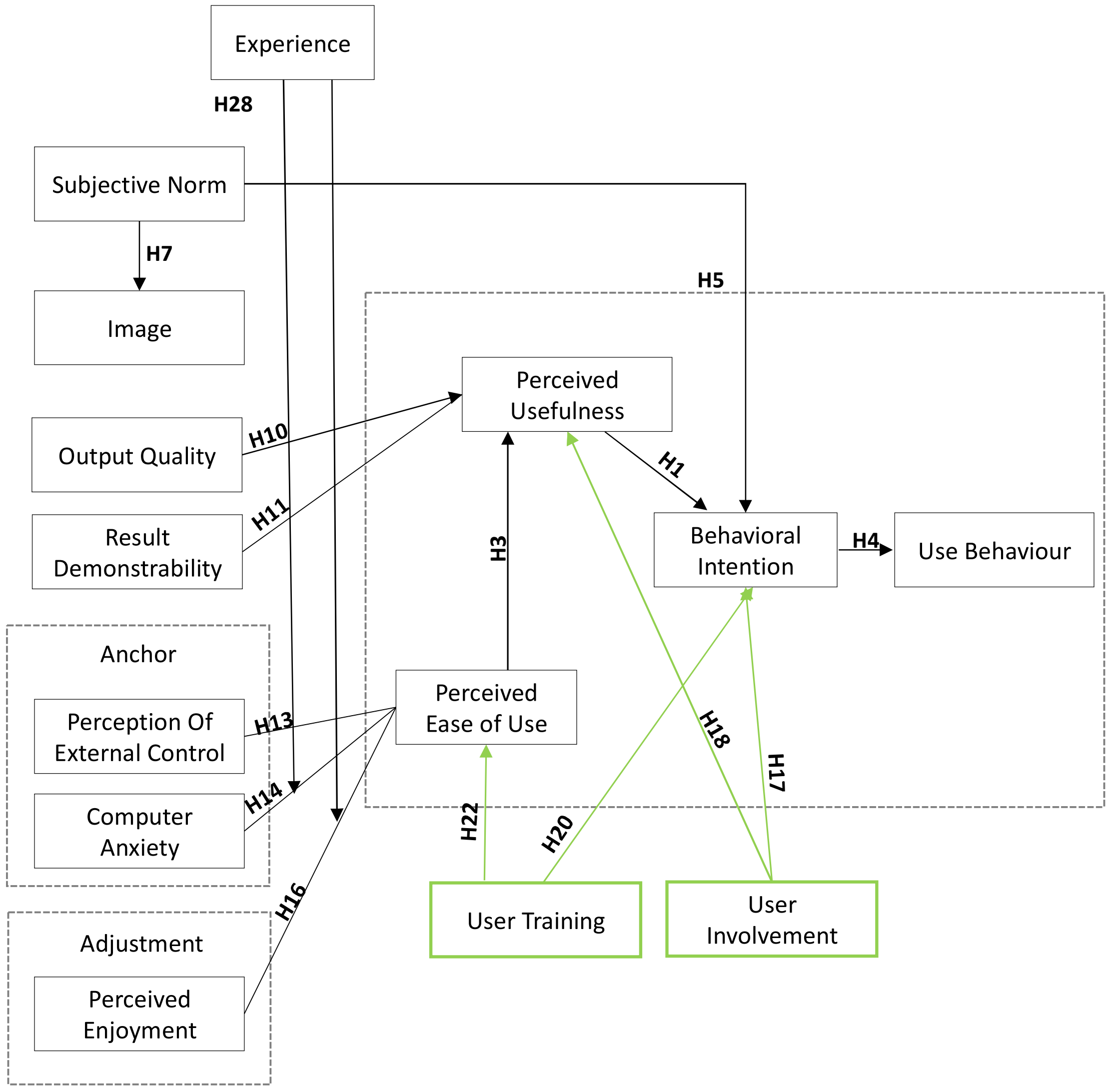


Figure 7-1 Final research outcomes model "Nursing Acceptance Model"

7.2.3 Reflections on Research Design

The strength of the research approach was the extensive time interacting and working with healthcare professionals and involved deeply with real implementation projects. This allowed good understanding of the context factors and reflecting on the nature of the problem during the different study cases.

The acceptance and adoption problem is complex with many hypotheses and factors. The PLS-SEM was used as a powerful tool for its ability to analysis and these complex relationships. The close PSMMC access generates a good number of nurses responses to allow PLS-SEM calculation.

On another hand, PLS-SEM limits the number of factors and hypotheses that could be incorporated.

7.3 HIT Adoption Framework Critical Factors

Literature review creates a lot of definitions and models of the challenges of HIT adoption by nurses. The current research addresses the main scope of the challenges (listing 34 critical factors), categorises them into four contexts (Section 6.9) and provides further information and explanation of these challenges that hinder HIT adoption. The structure of the full framework is created by integrating of Technology, Organisation and Environment (TOE) framework and Human, Organisational and Technological model (TOE combined with HOT-fit). In summary, the literature review and findings from the initial study and HIT implementation, shows that 12 factors are integrated in the framework and 34 sub-factors are distributed among the four key categories.

The major findings from the four case studies are useful to provide deep understanding of the issue and its challenges in relationship with Saudi context. Consequently, some new factors and critical elements are recognised. Several of these elements are hindering HIT successful adoption among nurses. Meanwhile other factors are considered as facilitator and progress supporting through the implementation and adoption process. Table 7-4 illustrates the proposed organisation of the critical factors list.

The new arrangement of critical factors add to the explanation of adoption, and contributes to the process of implementation when it is incorporated with the H-TOE framework. Changing sub-factor can affect another. For instance, changing “IT support and maintenance” factor by improving the IT team support will directly link to “low enthusiasm” among nurses towards accepting the HIT. Because a lot of system interrupting and failures create opposite reaction. This comes from the nurses’ feedback collected during the Nurtal system survey as illustrate in Appendix J.

Table 7-4 H-TOE critical factors list

Factors as facilitator	Critical Factors	Factors as barriers
	Technology	
Clear vision	**HIT Strategy**	Absence of Implementation Plan
	IT Infrastructure	Old Infrastructure
		Complexity
		IT Support and Maintenance
	Interoperability	Mapping and Integration
		Lack of standards
Interface Usability	**Information & Data**	Output Quality & Accuracy
	Organisation	
	Organisation Culture	Resistance to Change
		User Involvement and Participation
		Low enthusiasm
	Morality	Unprofessional Behaviour
		Sense of Responsibility
Awareness	**Top Management**	
Leadership Support		
	Environment	
Level of Education	**Cultural**	Tribal Impact
Gender		
Age		Blaming Culture
Nationality		
HIT Investment	**Economic**	Vendor Pressure
	Regulatory	National Healthcare National
		Market Uncertainties
	Human	
User Enjoyment	**System Using**	Anxiety
Result Demonstrability		Computer Self-Efficacy
	Human Capacity	User Training
		Shortage of Professionals
		Lose of Productivity
		Work overload

7.3.1 Cross Case Analysis of Critical Factors Linkage with PLS-SEM Analysis

Miles and Huberman (2014) indicate that cross case analysis is best used to get a better understanding and explanation of the facts; and increases generalisability. In cases, the findings can be valid in similar situations, this can be a case of generalisability. Each case study of the four cases was cross analysed against the rest of the three cases. The author was careful to keep consistency without losing the uniqueness of each case study.

The findings give two indications: one, how the factor is critical compared to another factor; two, predict the impact of each factor on other factor and each factor impact in future implementation. This will provide guidance to hospital management to take appropriate decisions to achieve successful HIT adoption at hospital. The analytic argument of these factors combined with tables and figures illustration, is presented in the next sections in brief.

The calculation used in critical factors tables and figures presents the researcher's opinion that is created from the data results displayed earlier. The researcher builds the classification of critical factors in order to help decision maker to prioritise their actions according to score of the factor's ranking. The assessment is depending on a score ranging from 0 – 4. In Table 7-5 explain the factors critical level in details and their best action toward it.

There are four levels in Table 7-5, which are arranged according to the scale:

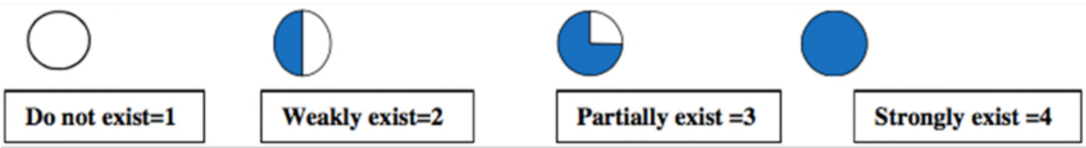


Table 7-5 Definition Classification of factors critical level

Factors critical Level	Range of Level	Type of actions
Highly Critical	0-2	In this level, direct and fast action is required. Here the decision is needed to be strong in order to get quick results thus balance the adoption level among factors.
Critical	2.25 - 3	In this level, high attention and emphasis is also demanded. Anyway, it is not supposed to exceed the previous level, yet decision makers have to make fast plans and stages in certain timeline and agenda.
Less Critical	3.25 - 4	In this level, likewise the factors are significant and crucial to administer, this due the lack of organisation funds, this include human resources and any needed resource. These less critical factors are not supposed to be a priority; unless the two higher levels factors were completely treated in a way to be less crucial.

The purpose of developing the Implementation Issues Framework is to assist decision makers by highlighting the highest to lowest critical factors and explaining how they interact and evolve in the HIT adoption process. Three steps are identified according to the researcher perception to explain how to implement the adoption framework aiming to obtain the best results and guidance.

1. Analyse the present status and work up the previous experience in order to have deeper recognition of factors and difficulties affecting the adoption process. By ranking challenges through a classification of the highest crucial factors this closes this level.
2. Introduce the framework in new aspects, or by omitting the factors that does not work with the active development in the environment.
3. With the aim of gaining appropriate balance among the aspects of development of technology, organisation, environment and human features.

7.3.1.1 Findings in Technology Factors

Technology critical factors across the four case studies are illustrated in Table 7-6 and Figure 7-2. In general, the technological context has the highest critical factors in average score of 2.3 out of 4 which need immediate and fast actions to get better. CPR system achieves the highest score in average of nine sub-factors 3.4. Meanwhile, the Pharmacy Automation System has received the lowest score 1.7.

Old infrastructure records the lowest score 1.5. Most of the MoH hospitals in Saudi Arabia are late in upgrading HIT system. By comparing case studies finding with literature review, old infrastructure is considered as the highest cited factor in Saudi context (6 times) but in the rest of the world it was regarded as a medium to low affected factor only (3 times). This indicates a good level of awareness and a clear vision nevertheless the old infrastructure is considered the main problem factor. Similar case is at PSMMC, they have launched an initiative known as the Health Informatics Department aiming to develop a robust information infrastructure in order to support the hospitals with reliable, timely and accurate medical information. However, this department is still at an early initial stage and many plans are in the process of development. Furthermore, as one manager explained *"The* PSMMC*'s IT infrastructure is very old and most of the systems were adopted 30 years ago, for example the HIS system has been operating since 1982. In addition, it runs a proprietary format database that is complicated* *to understand and to manage. Therefore, we are facing difficulties with the current IT infrastructure whenever a new technology or system is adopted"*.

Alkraiji, Jackson and Murray (2013) discuss this issue in their recent study and argued that many cases showed that the existing infrastructure has a negative impact on the adoption of health data standards referring to the King Faisal Specialist Hospital and Research Centre (KFSH&RC). For example, the hospital failed to adopt HL7 Context Management Specification (CCOW) since it requires some non-existent requirements and infrastructures to function properly. Although the inpatient pharmacy at PSMMC hospital has now adopted HL7 v2.3, limitations has occurred in the adopting the messaging standards with other departments which ended in project failure. In addition, Altuwaijri (2008) in his study explained the current status of HIT in healthcare provider in Saudi Arabia. He clarified that the majority of MoH hospitals around the KSA infrastructure is below standard due to insufficient funding. Also, most of the private hospitals and clinics have the minimum system requirements in terms of their HIT infrastructure and most of their system emphasis is on financial applications such as billing systems. In contrast, most of the tertiary hospital like KFSH&RC and PSMMC are equipped with the most advanced and recent HIT. This occurs because, they have an excellent annual budget allocated by the MoH and so the financing of HIT projects is not an issue there; they have the most highly qualified IT professionals in KSA because of the availability of the required budget and, they are considered the most advanced healthcare providers in the country. Thus, the MoH is keen to maintain the positions of these hospitals in accordance with international standards. Unfortunately, the number of these hospitals is still small, they are only located in major cities, and moreover, they are overloaded with patients.

Several studies have reported the IT infrastructure as an important factor in innovation technology adoption models and must be taken into consideration whenever a new system is to be adopted. According to Mozaffar *et al* (2016) the main cause of failure or delay in CPOE and CDS implementations in UK hospitals was due to lack of an appropriate HIT infrastructure. Khoumbati *et al.* (2006)

defines organisational readiness as the level of sophistication of IT usage and IT management in the organisation. So, organisational readiness is regarded as the capability of the existing infrastructure. The capability means that the new system should operate within the resources that are currently available in terms of technical issues (networks and platforms), human aspects, skills and knowledge. Hospitals have to make large investments in terms of HIT infrastructures. Thus, the hospitals will not need to discard any equipment as a result of the requirements for adopting the new standards or system unless the change is strongly justified. This idea was consistent with the previous studies as explained by Doebbeling, Chou and Tierney (2006) that an amount of the existing capital and equipment in hospitals could have negative impact on the adoption of system or standards in case of discard requirement in order to apply the new standard.

Old infrastructure, lack of mapping and integration, lack of standards can affect output quality. Output quality can affect directly the perceived usefulness for using HIT adoption. The result of analysis from Nurtal system is supported and confirmed that the **OUT** was found to be statistically significant in explaining **PU**. $p<0.001$, supporting hypotheses **H10**.

In the same time with indirect effect, the **OUT** was found to be statistically significant in explaining **BI** and **USE**. $p<0.012$, $p<0.033$ supporting hypotheses **H10**.

Table 7-6 Technology factors across cases

Technological Factors	Sub-factors	Pharmacy Automation System	Dispensing Discharge Medications System	CPR	Nurtal	Ave
ICT Strategy	Vision	○	◐	●	◕	2.5
	Implementation Plan	○	◐	●	◐	2.25
IT Infrastructure	Old Infrastructure	○	○	◐	◐	1.5
	Complexity	◐	◐	●	◐	2.5
	IT Support and Maintenance	○	◕	◐	◐	2
Interoperability	Mapping & Integration	◐	◐	●	◐	2.5
	Lack of Standards	○	○	◕	◐	1.75

Information & Data	Interface Usability	●	◕	◕	◕	3.25
	Output Quality & Accuracy	◑	◑	●	◕	2.75
Average		1.7	2	3.4	2.3	2.3

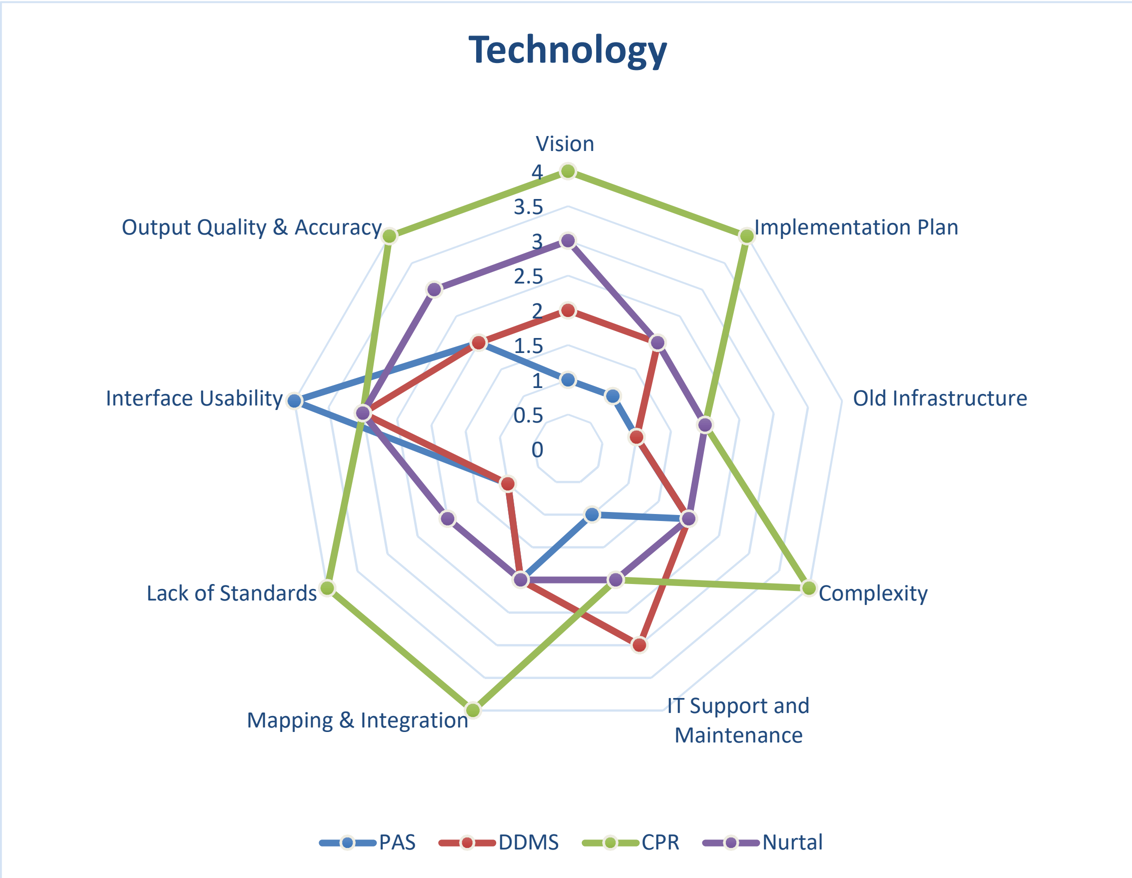


Figure 7-2 Radar diagram for technology factors

7.3.1.2 Findings in Organisation Factors

Several studies examining the organisational context for HIT adoption in developed and developing countries have identified similar factors (Al-Fakhri et al., 2008; Altameem, 2007; Al-Shehry, 2008). The analysis of the empirical data in this research confirmed the strong relationship between the factors that influence the acceptance of HIT and the identified organisational factors. Table 7-7 and Figure 7-3 show several types of organisation critical factors across that has intensely considered and well managed. The main and most critical factors that may decrease the satisfaction, commitment levels and adoption among nurses and pharmacists is “user involvement”.

User involvement can be divide into two types, pre- and post-implementations. Pre-implementation allows multidisciplinary team, representing different departments of the involved departments to participate in development of HIT. In our cases, the IT department is controlling the project and minimises the involvement. The head nurse comments on this point and said" *Our participation on implementing the Nurtal/ Pharmatal system is considered the weakest among the participation team because our IT skills. As we receive signs or indirect message from them "we know the best for you and the system you need, just write to us your requirement". Then, after long waiting, we received a system with a lot of features that is not needed or required".*

Post-implementation means continual involving the end user by getting feedback or upgrading the system.

The statistical findings from CPR and Nurtal systems indicate highly significant factors. The **UI** were found to be statistically significant in explaining **BI**, $p<0.055$, $p<0.006$, supporting hypotheses **H17**.

Our finding is supported by literature. For instance, Ives and Olson (1984) and Baroudi, Olson, and Ives (1986) studied over 20 articles and they found that involvement plays a role in better defining user requirements, providing better understanding on how to use the system in the organisation, enhancing the user's knowledge of the system. For that, they comprised user involvement as one of the success dimensions. The authors conclude that more user involvement lead to more users' satisfaction and system usage. DeLone and McLean (2003, p. 17) explained that user involvement "may *cause* success rather than being a part *of* success". More recent study conducted by Hartwick and Barki (1994) proposes user involvement as an intervening variable between user participation and system use. Firstly, they defined user participation and user involvement as separate constructs. Merging the constructs of participation and involvement into Fishbein and Ajzen framework (1975) Theory of Reasoned Action (TRA) of, a tested in a longitudinal field study of information system projects in the Canadian Information Processing Society. Six key findings emerge from the study. For example, the role of user participation and involvement is different. They seem to be important only for the voluntary users of a system rather than mandatory. Later on Hunton and Beeler (1997) adopted extended TRA framework for user involvement that was developed by Hartwick and Barki (1994) to examine the efficacy of user participation in developing an accounting application. The research revealed several findings. One of the main finding was that user attitude and involvement gains are significantly higher in the non-instrumental voice condition than in the no voice condition. The most recent study conducted by Sambasivan et al (2012) to understand the factors that influence adoption and therefore use of CDSS by physicians looked at seven public and five private hospitals in Kuala Lumpur. The study framework developed was based on UTAUT model. They use structural model analysis (SEM) to test the hypotheses. The result shows that there is a significant positive relationship between the level of involvement in decision making and intention to use the new CDSS ($r = 0.236$, p-value= $0.00 < 0.05$).

In contrast, user involvement is not supposed to be an important factor. Chang, Hwang, M.-C. Hung, *et al* (2007) analysed the factors affecting the adoption of e-signature through applying the Technology, Environment and Organisation (TEO) framework. A survey was conducted to confirm the validity of the research framework on regional hospitals and medical centres in Taiwan. The results show that the TEO framework is useful in distinguishing hospitals as adopters and non-adopters of e-signature. Also, User involvement was found not supported (not significant affect). The author believes that the Taiwanese study findings are different from previous studies for two reasons. The first reason is due to the differences of organisation in the industries which were surveyed in the previous studies. Meanwhile, in Taiwan hospitals are not like for-profit organisation. Taiwanese hospitals are highly centralised and as a result user involvement is regarded as a low effective factor in comparison with the different industries. The second reason is related to the healthcare technology vendors in Taiwan. The vendors offer complete solutions by providing gateways to on-site training. This connects the new technology to the buyers' IS which is supposed to decrease the system complexity in all hospitals.

The broad topics of user involvement and participation was studied by (Yang *et al.*, 2013) in: “Analysing the enabling factors for the organisational decision to adopt healthcare information systems”. They considered expanding user involvement to include government involvement and vendor partnership and the result found that they influence the adoption decision of a wireless vital signs monitoring system. After that, they grouped them under the factor of organisational mandate on their framework. According to Lorenzi *et al.*(1997) user involvement and participation can be combined to a set of factors which can be classified into three main groups:

- **Cognitive factors** are considered logically as the most easy factors to realise and assess. This include technology competence and experience in addition to individuals understanding of their role in the system and the related technology tasks and characteristics.
- **Motivational factors** drive inner motivation to use technology. This can be perceived in individual’s awareness, self-confidence, high belief in technology efficacy, and good expectations of technology.
- **Situational factors** are stated in relation to the environment and the society norms of user. These factors are understood through analysing the society tendency towards technology, available facilities, the implementation impact, the head of department expectations, the individual role in the implementation, and the effect of an individual implementation in comparative to others.

Another important finding highlighted in Table 7-7 is resistance to change. The use of HIT requires close collaboration between top management down to end user, different departments and related groups to achieve the required organisational change. This is because adapting new system is challenging and there are always some level of resistance from some parties. For example, some of IT managers are not interested about this change because they think that adopting health systems result in extra work and they are already overloaded. In addition, there are no incentives (e.g. money and professional accreditation) to motivate them to accept such changes. In regard to this, informatics pharmacist said *“the IT department managers do not accept changes and efforts to improve the hospital system until they face pressure from top management. This is because they think that they are overloaded. For that, we are facing many problems after the implementation”.*

This finding was supported by previous relevant studies. In the US, numerous studies have identified resistance to HIT such as EHRs (Organization, 2006). They mentioned that such resistance is very common, and it hinders EHR adoption. In fact, global studies have proven that one of the most common and widespread barriers in literature to implementing HIT is staff resistance to a change/new system. Recent research by Carnall (2014) reported that various physicians refused and resist to use the HIT in hospitals because they assume that these systems will disturb workflow and are time consuming. Therefore, they prefer to use “pen and paper”. Fitzgerald, Piris and Serrano (2008) observed that within HIT projects, there are always difficulties regarding the coordination of related groups and departments, as well as resistance to change among professionals. In this, Saudi Arabia is similar to the rest of the world. Hasanain and Cooper (2014) found resistance to using new technologies was one of the two social barriers identified to be obstructing EHR implementation in Saudi Arabia.

In some cases resistance to change is not always a barrier. For instance, In Table 2-4, Sedlmayr *et al* (2013) evaluate physicians’ use and acceptance of different interventions in an emergency department and identify reasons why interventions are adopted or rejected. Extended TAM2 model was developed with added the factors “resistance to change” and “compatibility” to workflow based on a literature review. The result of analysis showed that resistance to change was found to be not statistically significant in explaining usage intention.

The awareness factor is the best scoring 4 out 4 and considered the least critical factors. This credit can be credited to the KSA government when the “King Abdullah Scholarship Program” started in 2005. This program increases the level of awareness and broaden the horizon of the top manager and leader (Hilal, Scott and Maadad, 2015).

Table 7-7 Organisation factors across cases

Organisational Factors	Sub-factors	Pharmacy Automation System	Dispensing Discharge Medications System	CPR	Nurtal	Ave
Organisation Culture	Low Enthusiasm	◑	◑	◕	◑	2.25
	Resistance to Change	○	◑	◑	◑	1.75
	User Involvement	○	◑	○	◑	1.5
Morality	Professional Behaviour	◕	●	●	◕	3.5
	Sense of Responsibility	◕	●	◕	◕	3.25
Top Management	Awareness	●	●	●	●	4
	Leadership Support	◑	●	●	◕	3.25
Averages		2.3	3.1	3.1	2.7	2.8

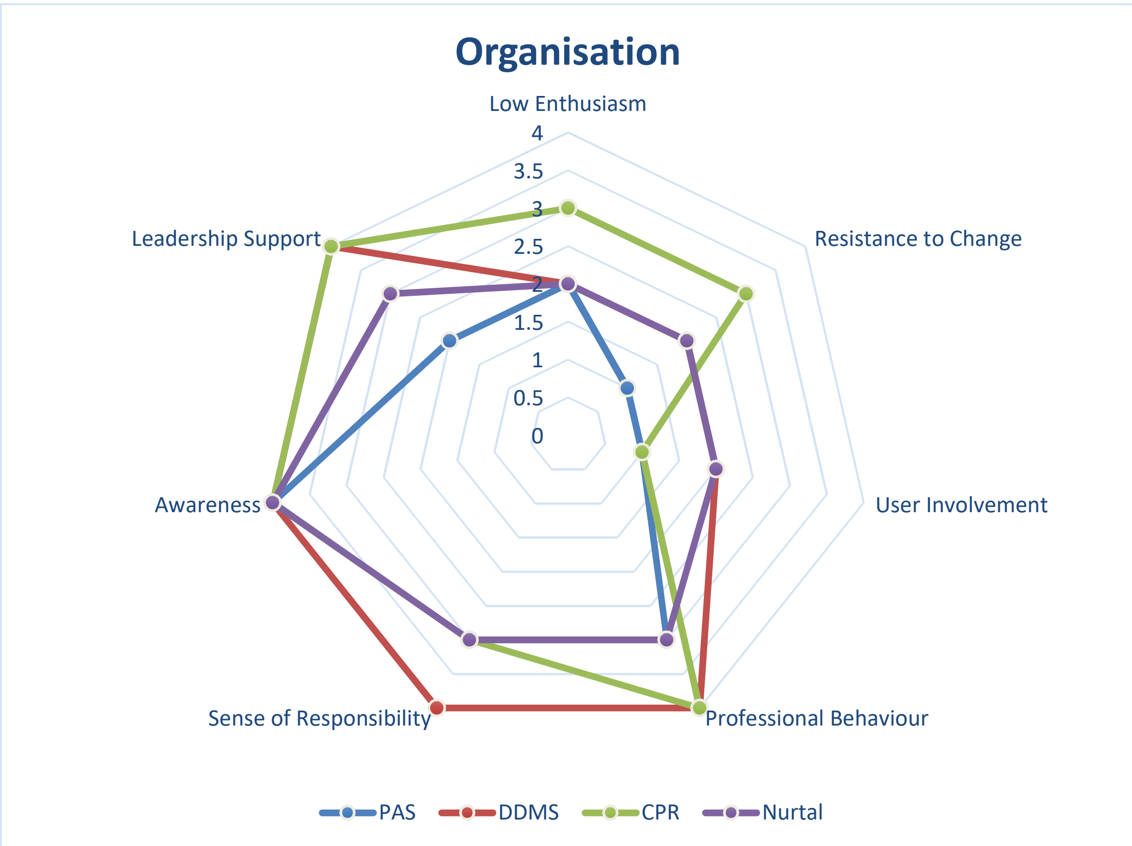


Figure 7-3 Radar diagram for organisation factors

7.3.1.3 Findings in Environment Factors

Table 7-8 and Figure 7-4 illustrate the level of environmental factors across the four case studies. This context gains the best score in average 2.93 out 4 in total among another factors.

Market uncertainty is one of the important factor and gets 2.25 score on average. In Saudi Arabia, many of the chief healthcare providers trust consultants and vendor of medical IT system and their related ethics. Leading vendors will customise the standards based on the hospital's requirements making sure that customisation is reasonable and that is also not in conflict with international standards. However, due to the lack of a national regulator in the medical IT systems market, some national companies do not comply with many of the necessary international specifications and standards. Some companies have also taken the advantage of the lack of experts in many hospitals to market their systems to some government and private healthcare providers. Unfortunately, due to the low expertise in many hospitals, some companies have taken this as a chance to market their systems to healthcare providers in the government and private sectors. As one of top manager at Heraa hospital said *"in 2007, we started the integration project with one of the national vendors and after several meetings we found that the company does not follow the international standards, which postponed the project plan until another vendor was chosen"*.

The market uncertainty in the literature was usually linked to issues of health data standards, market competition and healthcare providers. Hammond (2005) emphasis that the development of health data standards is lagging behind many major industries such as banking by at least 20 years. He explained this problem by two reasons: firstly, a serious lack of international efforts to establish and integrate the development of such standards. Secondly, market competition increased proprietary interests amongst the vendors of HIT applications. Jenders (2007) expanded on the market uncertainty that confuse the situation for potential adopters of health data standards. For instance, some standards developed for a particular market (e.g. the European market) cannot, in general, be applied in other (e.g. the North American market) without some modification. This happened due to the differences between countries regarding medical policies and procedures.

In the Saudi content, IT department managers described two problems they faced in the national health market. Firstly, for the leading companies and vendors of HIT to gain access to Saudi markets, they are required to have a national broker to become the authorised dealer. As a consequence, some brokers are not qualified to work or deal with HIT applications. This will lead to unsuccessful implementation and prevent market transparency. Secondly, some leading international companies prefer not to have a broker. They negotiate their deal with customers directly therefore the national market has lost some leading vendors[4].

The result shown in Table 7-8 illustrates that the effect of tribal factors is the least critical. Purchasing or adoption of a new system does not always depend on the policies, procedures and knowledge of healthcare professionals. Al-Shehry et al. (2006) has discussed this issue referring to the importance of the project team's enthusiasm and how they will perceive the value of this new adoption on the achievement of the project. Also, he also referred to how the support from top management and the allocation of the required resources. This sometimes depends on the relationship of management to the project team. It shows to some extent that the environment of Saudi Arabian culture is still revolved around the tribal system.

In Table 7-8 the level of education, gender, age and nationality gains the best result 3.75 out of 4 environmental factors amongst critical factors. This indicates that the diversity of nationality leads to lower tribal influence. Through the statistical analysis of data, the moderators in TAM3 **Level of Education, Age, and Gender Nationality** are not found statistically significant in relationship between **SN** and **BI**, supporting hypotheses **H23**, **H23**, **H24**, **H25** and **H26.**

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[4] This scenario of market was acquired to our first case study (pharmacy automation system) implementing Pyxis machine. This due to several failures to adopted health data standard. After that, main company take offer the project and compete the implementation successfully.

Table 7-8 Environment factors across cases

Environmental Factors	Sub-factors	Pharmacy Automation System	Dispensing Discharge Medications System	CPR	Nurtal	Ave
Regulatory Economic	National Healthcare System	○	◕	◕	◑	2.25
	Market Uncertainties	◑	◑	◕	◑	2.25
	Vendor Pressure	○	◑	◕	◑	2
	HIT Investment	◕	◕	●	●	3.5
Cultural	Tribal Impact	◕	◕	●	◕	3.25
	Blaming Culture	◑	◑	◑	◑	2
	Level of Education	●	●	●	◕	3.75
	Gender	●	◕	●	●	3.75
	Age	◕	●	●	●	3.75
	Nationality	◕	◕	◕	◕	3
Average		2.6	2.9	3.4	2.9	2.95

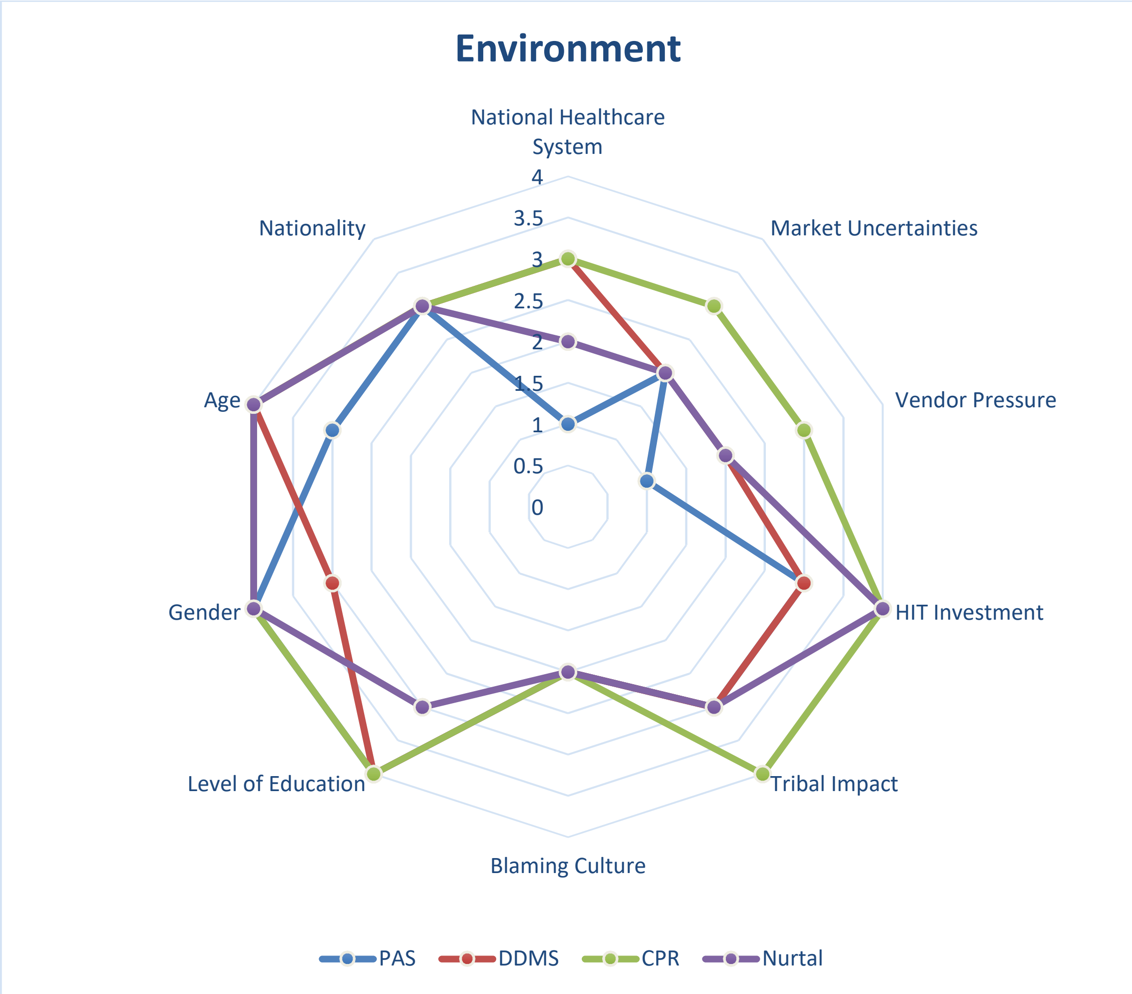

Figure 7-4 Radar diagram for environment factors

7.3.1.4 Findings in Human Factors

In Table 7-9 the result shows clearly that in the pharmacy automation system productivity, user training and user enjoyment are measured highly, score 1 out of 4. Its relationship can be explained by cause and effect. Low productivity causes by weak user training results in low user enjoyment and high anxiety.

Likewise, this finding has been supported and confirmed by the PLS-SEM analysis in CPR and Nurtal systems. The **UT** are found to be strongly statistically significant in explaining **BI** and **PEOU** p<0.000, supporting hypotheses **H22** and **H20**. Furthermore, the **ENJ** are found to be strongly statistically significant explaining **PEOU**, p<0.000, supporting hypotheses **H16**.

In the Nurtal system, **CANX** is found to be statistically significant in explaining **PEOU**. p<0.038, supporting hypotheses **H14.**

In literature review, poor user training is usually considered as barriers to adoption HIT, as in Table 2-2 and

Table 2-3. Jha *et al*, (2009) conducted survey to determine whether physicians who care for black and Hispanic patients adopt, use and have satisfaction on EHR systems at comparable rates. They found training and productivity loss as reported barriers to beginning or expanding the use of computer technology.

In the Saudi content, in Table 2-6, user training was found as the top factor that affect the HIT adoption (10 times). For example, Zaher (2012) addresses the whole scope of barriers (organisational, human, technical, financial and political) to KM implementation ranging from hospital peculiarities to a comprehensive framework for addressing the problem. He found 26 barriers and categorised them into major impact, minor effect, and no impact. One of the finding is “Lack of IT Training” under “Technical Barriers” and the result shows no impact in implementing KM in Saudi hospitals.

The feedbacks of nurses and pharmacists’ on the questionnaire survey are shown in Appendices **J & K.** It reveals that user training was requested for a diverse range of skills and reflected the lack of user training in PSMMC hospital. The quotation from participant nurses said, *“Train New Nurses*”, *“Continuous Training*”, *“Training should be offered every month or quarterly”*, *“Training should be provided before the system implementation”* and *“Train the pharmacist”.* Meanwhile, participants pharmacists’ said: “Pharmatal is easy to use but it needs more training for nurses because until now they call to ask about the order sending…” and *“I think that the outcome will be better when Pharmatal training and understanding is offered for both nurse and pharmacist”.*

Summing up, the arguments and analysis above support the extension to the TAM3 model to include ‘User Training’.

National professionals play a vital role in the development of HIT in healthcare organisations and their shortage hinders such development. In Table 7-9, the shortage of professional factor is 2.25 out of 4. The majority of the participants agreed on the shortage of the national professionals is one of the main factors that affect the integration. Informatics pharmacist indicated that "*There is a need for more expert Informatics' pharmacist in addition to the need for professional training in the health data standardisation*".

The reason is due to the complexity of the health information systems, it requires expert professional and analysts. More important, the current training and university programmes do not meet the recent development in the field of medical informatics science. Health organisations in Saudi Arabia are relatively new in the domain of advanced medical technology. In light of this, the head pharmacist said *"Our plan is to send students abroad, in fact two pharmacists are sent abroad to attend a one year programme in special areas of Health Informatics".* According to the head pharmacist this initiative will help to provide enough health informatics in each department. In addition, the healthcare vendor company of Pharmacy Automation System said *"After the implementation of the new system, we found a lot of insistences from most of IT team to run extra training sessions in Rhapsody integration (HL7)".*

Table 7-9 Human factors across cases

Human Factors	Sub-factors	Pharmacy Automation System	Dispensing Discharge Medications System	CPR	Nurtal	Ave
System Using	Anxiety	◐	◕	◐	◐	2
	Computer Self-Efficacy	◐	●	●	◕	3.25
	Result Demonstrability	◐	◕	●	◕	3
	User Enjoyment (-)	○	○	●	◐	2
Human Capacity	Productivity (-)	○	◐	◕	◐	2
	User Training (-)	○	●	◕	○	2.25
	Work overload	◐	◐	●	◐	2
	Shortage of Professionals	◐	◐	●	◐	2.25
Average		1.75	2.4	3.5	2.25	2.4

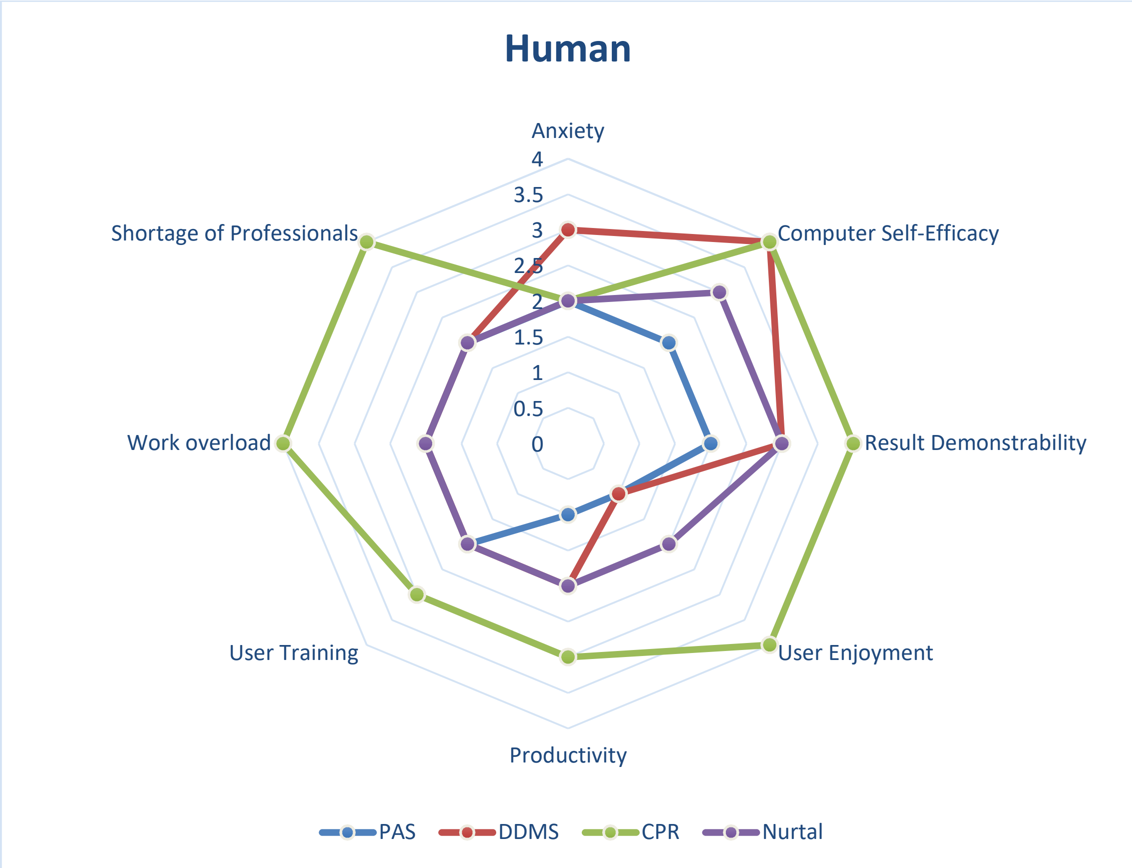

Figure 7-5 Radar diagram for human factors

Table 7-10 and Figure 7-6 shows a list of critical according to their classification level.

Table 7-10 List of critical factors classification of factors critical level

Level	Factor	Average
Highly Critical	User Involvement	1.5
	Old Infrastructure	1.5
	Resistance to Change	1.75
	IT Support and Maintenance	1.75
	Lack of Standards	1.75
	User Enjoyment	2
	Productivity	2
	Implementation Plan	2
	Vendor Pressure	2
	Blaming Culture	2
	Anxiety	2
	Work overload	2
Critical	Low Enthusiasm	2.25
	Vision	2.25
	Shortage of Professionals	2.25

	Complexity	2.5
	National healthcare system	2.25
	Market Uncertainties	2.25
	Mapping & Integration	2.5
	Output Quality & Accuracy	2.75
	User Training	2.25
	Nationality	3
	Result Demonstrability	3
Less Critical	Computer Self-Efficacy	3.25
	Leadership Support	3.25
	Tribal Impact	3.25
	Interface Usability	3.25
	Sense of Responsibility	3.25
	HIT Investment	3.5
	Professional Behaviour	3.5
	Level of Education	3.75
	Gender	3.75
	Awareness	4

Table 7-11 illustrates suggested solutions for the highly critical factors as well as important actions needed.

Table 7-11 Suggested solutions for highly critical factors

Factor	Suggested Solutions
User Involvement	• Create online form that enables the nurses to give feedback easily
Old Infrastructure	• Adopted short term strategies and plans to upgrade the HIT in order to cope with international standards
Resistance to Change	• Publish the master plan for the future HIT project on the internet in order to rise gradually the awareness and acceptance
IT Support and Maintenance	• Allow third parity to access the IT team
Lack of Standards	• Apply international standards • Reject any national HIT project that does not use international standards
User Enjoyment	• Introduce the benefit of using new HIT by making the work more ease of use. • Promote HIT through spreading positive massages in working environment about it potential influence on their work productivity and outcome.
Productivity	• Make sure the all required materialistic supplies are available in work station
Implementation Plan	• Design a long, medium and short terms plan • Establish a committee responsible for design implementation plan
Vendor Pressure	• In implementing contract agreement, it is necessary to write a penal condition in case of any failure of the system and in case of any delay.
Blaming Culture	• Understanding the culture and attitudes before sitting the roles. • Make the instruction about benefit of blame free toward reporting medication errors.
Anxiety	• Training (before go-live) • Continuous training (After go-live) • Train new nurses • obligatory training every month or quarterly • Train the trainer

	• One-one training • On line training
Work overload	• Clear guide line for each employee duties

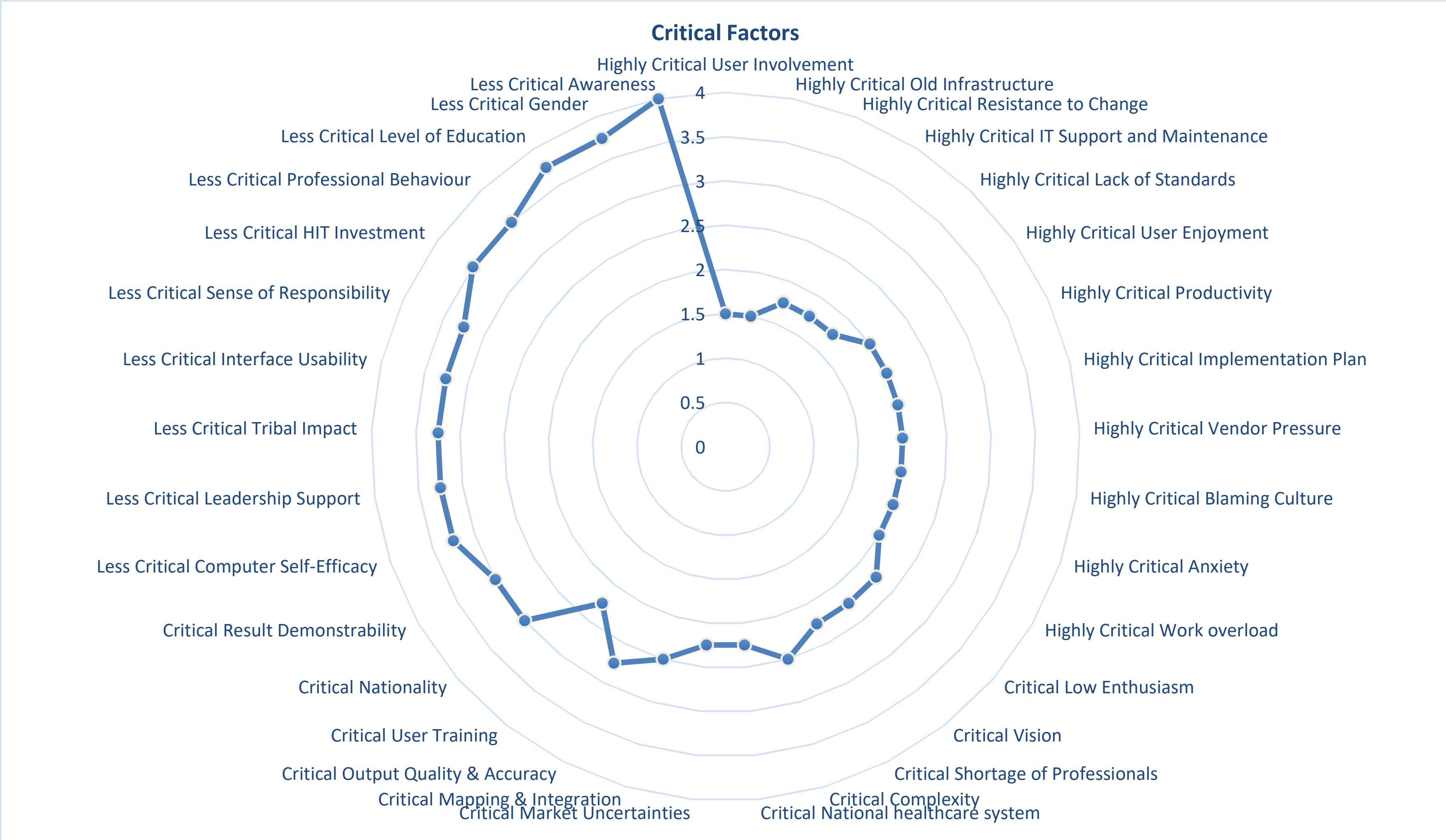

Figure 7-6 Critical Factors (three level)

7.4 Research Contributions

7.4.1 Reflections against research objectives

The following sections reflect on the achievement of the research objectives.

7.4.1.1 Objectives 1 and 2: from literature review

- To understand challenges and barriers which affect user adoption of IT.
- To review models and frameworks used for nursing HIT adoption.

The first and second objectives were developed to discuss, compare, contrast and critique the literature related to the factors that influence the acceptance of HIT among nurses at Saudi hospitals. Also, the literature examined specific IS adoption theories and why TAM3 theory are considered relevant for examining the end user acceptance. Problems and gaps were addressed and formed four factors (technology, organisational, environment and human) in separate diagrams.

7.4.1.2 Objectives 3: from HIT Implementation Issues (initial case studies)

- To model the nature of HIT issues with in depth cases in Saudi hospital

The Initial Implementation Issues Framework was created as one comprehensive picture (H-TOE model) to understand critical factors for HIT adoption among nurses. There were two studies in this stage, and each study is reported in detail with the purpose, methodology, results and findings.

7.4.1.3 Objectives 4: from HIT Implementation Case Studies

- To design and execute field research to collect data of nurses HIT adoption, through participation in real life HIT system implementation projects in Saudi hospitals

In this objective, deep understanding of HIT was achieved via two real life case studies implementations. The two studies was conducted in order to validate H-TOE framework as factors to extend the TAM3 model. User involvement (UI) and user training (UT) was added as independent variables. 28 hypotheses in the study were created.

7.4.1.4 Objectives 5: from Nurses Acceptance Model (Validation)

- To build a model of nurses adoption of HIT implementation

The validation of data showed that the model had an acceptable fit and more than half of the hypothetical variables were significant (14 hypotheses out of 22). User involvement and user training were confirmed. This finding has been analysed by using PLS-SEM for nurses' acceptance of the CPR and Nurtal systems. UT and UI were found to be statistically significant in explaining PEOU, PU and BI, supporting hypotheses H17, H18, H19 H20, H21 and H22. The seven success factors together explained 65.6% of the variances in TAM3 model. The results powerfully suggest that the model has considerable explanatory influence in behavioural intention that will predict user acceptance.

7.4.1.5 Objectives 6: from Recommendations for Decision Makers

- To offer a number of recommendations for decision makers to achieve successful HIT adoption in the Saudi healthcare organisations.

In order to implement the framework in Saudi hospitals, decision makers should be considered as highly critical factors as immediate actions are needed to be solved. In addition, it is necessary not to neglect the (medium and low) critical factors during the HIT implementation. Table 7-11 could be used as guidelines to prepare for HIT acceptance.

7.4.2 Theoretical Contributions

The outcome of this study provides novel contributions into the present state of HIT. It is adding to the existing literature about HIT adoption among nurses through several inputs:

1. **Extended TAM3 model**: Based on the available and updated literature review on HIT studies in the Saudi Arabia, this is the first study to use and apply the TAM3 model to determine and study critical factors that influence nurses to accept and use HIT in the Saudi Arabia study context. The study used a modified TAM3 model as a basic theoretical model, which was amended by adding user training (UT) and user Involvement (UI) as independent variables and changing output quality (OUT) form moderator

to independent variables. The study also added education, nationality, gender and age moderators in the original TAM3 model to behavioural intention.

Referring to literature review in Section 2.4 the history of TAM, its benefits, the importance of UT and UI as compared with paper based process in Table 2-2 +

Table 2-3 and then Table 2-4 + Table 2-5, we can notice that applying these factors can have positive influence and assure success on HIS (implementation + adoption) in hospitals. Because they play major roles in involving all the employees and providing them training for all the phases of the HIT project implementation from (A to Z).

2. **Integration between TOE and HOT-fit framework**: Wrapped around the Extended TAM3 results, this research propose the "Implementation Issues Framework for HIT adoption" as a holistic picture that integrates multiple perspectives by examining critical factors on technology-organisation-environment-human levels in Saudi Arabia (critical factor framework). This helps decision-makers to gain a deeper understanding of the complexity behind HIT adoption. The critical factors assisted in filtering the necessary factors that must exist prior an implementation project.

   The H-TOE framework can help policy and decision makers in Saudi Arabia to better deal with issues related to the adoption process and guide them to balance HIT adoption priorities and more effectively implement systems to accelerate hospital development. Managing the changes in the dynamic environment is difficult because decision makers are suffering when specifying, dealing and managing these barriers and facilitators. Thus, the holistic framework helps to achieves successful implementation.

3. **Basis to other domain or contexts**: The research result provides a basis for future research to other domain e.g. g-government, e-business or contexts.

   The research can be generalised in Saudi context and could be applied to another domain since the study have strong foundation results. The strength lies in the data that was gathered from two different organisational contexts (military and ministry hospitals), and from different regions (west and central of Saudi Arabia), using a multi method (survey, interview and experiment) and a multi set of respondents (nurses and pharmacists) at a multi-point in time (cross-sectional –survey- and longitudinal -pre and post implementation-). The research built a robust level of understanding intra-cultural issues in the perspective of acceptance and usage of HIT. However, more countries need to be studied in order to fully generalise the study at a cross-cultural level.

4. **New insights on HIS adoption in Saudi**: The findings have confirmed computer playfulness, computer self-efficacy, job relevance were not statistically significant influence of HIT adoption. This is an extra contribution this study added to the literature.

   The new findings were opposite to the previous studies in these relationships. By examining and evaluating previous findings, the new finding is considered useful. Since HIT is complex and dynamic, the adoption behaviour by new users could change every decade. Therefore, it is necessary to understand these changes in culture, organisation, technology and human behaviour toward technology. This work in this research helps decision makers in the hospital to better understand the change they have to manage.

7.4.3 Practical Contributions

1. **The development of new HIT systems and implementation steps**: Hospital management are now concerned about potential factors that are important for HIT implementation success. The Nurtal/Pharmatal communication system and CardioPulmonary resuscitation (CPR) combined with (CDSS system) are examples of future HIT implementation processes in Saudi hospitals. With the research results Table 7-10 and Table 7-11, they can use the acceptance framework to develop future planning, considering the potential future problems, and make adjustment actions throughout the implementation. The management can be guided to focus on key areas and minimise the risk of HIT implementation failure.

2. **Reducing the medication errors**: Effective use of new HIT (outcome of systems implementation) help the nurses to avoid potential of medication errors.
3. **Developing the conceptual foundations for future HIT implementation**: The Saudi hospital cases in this research is representative of health system improvements particularly in developing countries such as Saudi Arabia. This study results reveal the present concern about potential factors that are vital for HIS adoption success for hospital management. The model could be used to help to improve early planning, and take corrective action through the different stages of implementation.

7.5 Limitations and Future Research

Although this research has achieved its aim and answered the main research questions there are limitations. These limitations are highlighted in the next two sections.

1. Cases only in military tertiary hospitals. This represent a specific working culture that may not be the same in other hospitals.
2. The discussion and analysis of HIT implementation and adoption are focused on the Saudi context. Time does not permit cross culture research, including national, religion, to be fully explored.
3. Multi-group analysis is not conducted to assess the moderating effects. Additional hypothesis to study these effects will require more survey responses. The current research model requires a minimum of 90 responses. For a more complex model, the research needs to have larger samples to do multi-group analysis and explore the differences e.g. between gender.

7.6 Future Work

1. **Impact of multicultural among nurses**: As 90% of the collected responses are from non-Saudi nurses' employee, it would be interesting to study the impact of multicultural characteristics. The results in this

aspect produced new findings and indicated surprising behaviours and attitudes among nurses toward using HIT. These behaviours and attitudes had a strong and positive influence and (or negative in some cases e.g. like reporting medication errors) in the adoption of HIT. Future work can examine the multicultural diversity factor and test its characteristics more intensively. The outcome from such study could be very significant in terms of introducing new HIT technology and its adoption, even in the UK NHS where the nursing staff is also diverse.

2. **Sense of responsibility**: It was observed that nurses and pharmacists could accuse each other, e.g. with STAT, ASAP medication orders or rejection of medication without giving reasons. Future work can be done to examine the sense of responsibility between healthcare professionals and how it affects the technology acceptance.
3. **Critical morality factors**: Sense of responsibility, unprofessional behaviour, sense of responsibility and tribal impact are factors well known by management and have sensitivity connected with diversity of culture and power of traditions. As a result, it was not studied deeply. Future work can investigate it deeply to understand these issues scientifically.

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APPENDICES

Appendix A Interview Questions Interview questions, Documentation, BPMN Diagram (First Case Study)

A.1 Pharmacy Department

Interviewee: Head of the pharmacy automation team and Informatics' pharmacist

- What is your position/Work? (Job Title).
- What is the current enterprise systems used at your department?
- Could you describe the current systems?
- How many branches does the hospital have? Are there links in the systems between your department and the other branches?
- Who uses the systems?
- How long does it take to implement the Rhapsody Integration Engine (HL7)? does the contract involve maintaining?
- Describe the workflow and the use for inpatient pharmacy and Pyxis?
- What the main reasons for adoption Rhapsody?
- Who initiated the idea of adopting Rhapsody?
- Who the vendor that provided Rhapsody and Pyxis?
- Which year was the implementation?
- Does health data standards activities, either at a national or international level, impact on the adoption of Rhapsody standard?
- Did you/your team involved in Rhapsody development? (IT, Doctor and Physician).
- Is these activities (e.g. promotion and awareness raising, information and technical support, consultant support and government support ... etc) have been carried out by the Saudi Ministry of Health (MOH) and/or other parties to encourage and support the uptake of health standards?

Problems

- Are you satisfied with the current level of integration achieved?
- Are you satisfied with working with the hospital team?
- Does the your department facing any problem in inpatient pharmacy or Rhapsody? OR to integrate with different systems?

- What were the main problems that your department faced before/after-adopting Rhapsody?
- What the action to take to solve the communication problem between HIS, Rhapsody and Pyxis?
- What solutions are being introduced to overcome these barriers?

Kind of Problems

- Is there any impact by cost on Rhapsody adoption in your hospital?
- Is there a shortage of health professionals? Please explain
- Is there any Market uncertainty/lack of a national regulator in the medical IT systems market?
- Is there any kind of resistance to change which faced before/after adopting Rhapsody?
- What is your future plane?

A.2 IT Department

Interviewee: Senior Information System Architect, Manager of Data Warehouse Systems analyst and Database Administrator

1. What is your position/Work? (Job Title)
2. What is the current enterprise systems used at the hospital?
3. Could you describe the current systems?
4. How many branches does the hospital have? Are there links in the systems between your department and the other branches?
5. Are the existing HIS share information with other the system? Which?
6. Who uses the systems?
7. How long does it take to implement the Rhapsody Integration Engine (HL7)? does the contract involve maintaining?
8. Describe the workflow and the use for inpatient pharmacy and Pyxis?
9. How is your HIS infrastructure organised?
    a. Is there any central integrated infrastructure or does each hospital have its own infrastructure? Please explain.
    b. What is the big picture of the integrated IT infrastructure in your hospital?
10. What the level of integration?
11. Could you specify the name of health data standards that are implemented in the hospital?
12. What the main reasons for adoption Rhapsody?

13. Who initiated the idea of adopting Rhapsody?
14. Who the vendor that provided Rhapsody and Pyxis?
15. Which year was the implementation?
16. Does health data standards activities, either at a national or international level, impact on the adoption of Rhapsody standard?
17. Which team involved in Rhapsody development? (IT, Doctor and Physician).
18. Is these activities (e.g. promotion and awareness-raising, information and technical support, consultant support and government support ... etc) have been carried out by the Saudi Ministry of Health (MOH) and/or other parties to encourage and support the uptake of health standards?

Problems

19. Are you satisfied with the current level of integration achieved?
20. Are you satisfied with working with the hospital team?
21. Does the hospital facing any problem in HIS system or Rhapsody? OR to integrate with different systems?
22. Were there any concerns about the current IT infrastructure before adopting Rhapsody?
23. What were the main problems that your department faced before/after-adopting Rhapsody?
24. What the action to take to solve the communication problem between HIS, Rhapsody and Pyxis?
25. What solutions are being introduced to overcome these barriers?

Kind of Problems

26. Is there any impact by cost on Rhapsody adoption in your hospital?
27. Is there a shortage of health professionals? Please explain
28. Is there any market uncertainty/lack of a national regulator in the medical IT systems market?
29. Is there any kind of resistance to change which faced before/after adopting Rhapsody?
30. What is your future plane?

A.3 Doctor (use Pyxis)

1. What is your position/Work? (Job Title)
2. What is the current enterprise systems used at your department?
3. Could you describe the current systems?
4. Are the existing HIS share information with other the system? Which?

5. Who uses the systems?
6. Describe the workflow and the use for inpatient pharmacy and Pyxis?
7. What the main reasons for adoption Rhapsody?
8. Who initiated the idea of adopting Rhapsody?
9. Who the vendor that provided Rhapsody and Pyxis?
10. Which year was the implementation?
11. Does health data standards activities, either at a national or international level, impact on the adoption of Rhapsody standard?
12. Did you/your team involved in Rhapsody development? (IT, Doctor and Physician).
13. Is these activities (e.g. promotion and awareness-raising, information and technical support, consultant support and government support ... etc) have been carried out by the Saudi Ministry of Health (MOH) and/or other parties to encourage and support the uptake of health standards?

Problems

14. Are you satisfied with the current level of integration achieved?
15. Are you satisfied with working with the hospital team?
16. Does the hospital facing any problem in HIS system or Rhapsody? OR to integrate with different systems?
17. What were the main problems that your department faced before/after-adopting Rhapsody?
18. What the action to take to solve the communication problem between HIS, Rhapsody and Pyxis?
19. What solutions are being introduced to overcome these barriers?

Kind of Problems

20. Is there any impact by cost on Rhapsody adoption in your hospital?
21. Is there a shortage of health professionals? Please explain
22. Is there any market uncertainty/lack of a national regulator in the medical IT systems market?
23. Is there any kind of resistance to change which faced before/after adopting Rhapsody?
24. What is your future plane?

A.4 Nurse Responsible for Pyxis

1. What is your position/Work? (Job Title)
2. What is the current enterprise systems used at your department?

3. Could you describe the systems?
4. How many branches does the hospital have? Are there links in the systems between your department and the other branches?
5. Who uses the systems?
6. Describe the workflow and the use for Pyxis?
7. Did you/your team involved in Rhapsody and/or Pyxis development? (IT, Doctor and Physician).

Problems

8. Are you satisfied with the current level of integration achieved?
9. Are you satisfied with working with the hospital team?
10. Does the hospital facing any problem in HIS system or Pyxis? OR to integrate with different systems?
11. What were the main problems that your department faced before/after-adopting Rhapsody?
12. What the action to take to solve the communication problem between HIS, Rhapsody and Pyxis?
13. What solutions are being introduced to overcome these barriers?

Kind of Problems

14. Is there a shortage of professional staff in your department? Please explain
15. Is there any kind of resistance to change which faced before/after adopting Rhapsody?
16. What is your future plane?

A.5 Reception Team

1. What is your position/Work? (Job Title)
2. What is the current enterprise systems used at the hospital?
3. Could you describe the current systems?
4. Who uses the systems?
5. Is the ADT system share information with other the system? Which?
6. Who uses the systems?
7. Did you/your team involved in Rhapsody and/or Pyxis development? (IT, Doctor and Physician).

Problems

8. Are you satisfied with the current level of integration achieved?

9. Are you satisfied with working with the hospital team?
10. Does the hospital facing any problem in HIS system or Rhapsody? OR to integrate with different systems?
11. What were the main problems that your department faced before/after-adopting Rhapsody?
12. What the action to take to solve the communication problem between HIS, Rhapsody and Pyxis?
13. What solutions are being introduced to overcome these barriers?

Kind of Problems

14. Is there a shortage of health professionals? Please explain
15. Is there any kind of resistance to change which faced before/after adopting Rhapsody?
16. What is your future plane?

A.6 Vendor (Head of Maintenance Team)

- What is your position/Work? (Job Title)
- Could you describe the current system that you implement in the hospital?
- Are there links between your systems and other branches?
- Who uses the systems?
- How long does it take to implement the Rhapsody Integration Engine (HL7)? does the contract involve maintaining?
- Describe the workflow and the use for inpatient pharmacy and Pyxis?
- What is the big picture of the integrated IT infrastructure in your system?
- What the level of integration?
- Is there any integration in your system with other health data standards in the hospital?
- What the main reasons for adoption Rhapsody?
- Which year was the implementation?
- Does health data standards activities, either at a national or international level, impact on the adoption of Rhapsody standard?
- Which team involved in Rhapsody development? (Clinicians, IT and Medical).
- Is these activities (e.g. promotion and awareness-raising, information and technical support, consultant support and government support ... etc) have been carried out by the Saudi Ministry of Health (MOH) and/or other parties to encourage and support the uptake of health standards?

Problems

- Are you satisfied with the current level of integration achieved?
- Are you satisfied with working with the hospital team?
- Does the hospital facing any problem in HIS system or Rhapsody? OR to integrate with different systems?
- Were there any concerns about the current IT infrastructure before adopting Rhapsody?
- What were the main problems that your department faced before/after-adopting Rhapsody?
- What the action to take to solve the communication problem between HIS, Rhapsody and Pyxis?
- What solutions are being introduced to overcome these barriers?

Kind of Problems

- Is there a shortage of health professionals? Please explain
- Is there any lack of a national regulator in the medical IT systems market?
- Is there any kind of resistance to change which faced before/after adopting Rhapsody?
- What is your future plane?

Table A-1 Summarise The interview outcomes

	Context	Organisation	Workflow	IT system	Web Doc
Head of the pharmacy automation	1. **Interview** (explore 20-30 min) (understand the hospital system - inpatient pharmacy – type of patient - working hours).	2. **Observation (workshop)** (To Introduce and arrange the pharmacy meeting). 3. **Observation (workshop)** (To draw the general borders of BPMN for each department). 4. **Documentation-Future Plane** (e.g. Cytotoxic Automation, Robotics Filling and IV Automation). 5. **Interview** (explore - about project barriers and challenges).	6. **Interview** (explore 25 min) 7. **Interview** (in-depth 1H – all the process using the inpatient system). 8. **Interview** (correct record – BPMN workflow - 30 min multiple time and email).	9. **Documentation - Database** (Extract monthly report form Oracle through SAP). 10. **Documentation-Email** (Rhapsody Failure/ Rhapsody server error for sending orders in Pyxis).	
Informatics pharmacist		11. **Interview** (detail – 1H - about policy and the role – e.g. lack of cost). 12. **Interview** (correct record - 1H – BPMN workflow).	13. **Interview** (correct record – BPMN workflow). 14. **Observation (workshop) (**To draw BPMN of task of the pharmacy workflow and describe their processes).	15. **Interview** (detail – monitor inpatient pharmacy). 16. **Documentation-Email** (medication timing or interval dosing is not showing to alert the staff of what is the due medication in certain time). 17. **Documentation - Email** (no communication with Rhapsody after updating Oracle, Oracle continuously sending update request to database and the database got hanged as well it slowing Rhapsody).	
Reception			18. **Observation** (use ADT & inpatient system). 19. **Interview** (explore - 35 min - understand the work).		
Vendor				20. **Interview** (detail- 2H & 10 min Rhapsody and Pyxis implementation, problem with IT team, future plan).	

Nurse		21. **Documentation-Quick Guide** (Procedures of reporting Pyxis problem).	22. **Observation** (use ADT & inpatient system - feeding the machine with Informatics pharmacist). 23. **Interview** (detail - 1&5 min) understand the work).		24. Tutorial for using Pyxis for YouTube
Doctor			25. **Observation** (15 min - process for describe a patient – mainframe). 26. **Interview** (explore – 30 min - process for describe a patient – mainframe).		
System Analyst	27.	28.	29. **Documentation** (Copy from pharmacy data workflow diagram).	30. **Observation** (using oracle – rhapsody – Mainframe).	
Manager of Data Warehouse and Senior Information System Architect	31.	32. **Observation (workshop)** (Introduce and arrange IT team meeting). 33. **Interview** (explore - 30 min – explain natural of work for Ward, IT System department and receptionist). 34.	35. **Interview** (Detail - Oracle – Rhapsody 1h &15min). 36. **Observation (workshop)** (to draw BMPN focusing on the infrastructure level).	37. **Documentation - Database** (Copy from Rhapsody Configuration Handling). 38. **Documentation - Database** (Copy from RMH rhapsody training Material). 39. **Documentation - Database** (Copy from Orion Health Rhapsody Brochures). 40. **Documentation-Email** (Error - Rhapsody not Receiving ADT). 41. **Interview** (correct record – BPMN workflow update -patient record – fix any technical problem relate to pharmacy and Pyxis).	
Database Administrator	42.	43.	44. **Interview** (correct record-IT Workflow part (30 min).	45. **Documentation - Database** (Extract schema from (Oracle – Rhapsody).	49.

				46. **Documentation-Email** (mapping IV orders to create rhapsody HL7 message file). 47. **Email** (Not receiving any order from the rhapsody need to power shutdown server to work). 48. **Interview** (detail – monitor inpatient pharmacy system).	

Table A-2 Analysis of the barriers to the adoption of health information systems in Saudi hospitals based H-TOE

	Barriers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Organisational Barriers	Lack of awareness (4)	*						*	*							*		
	Lack of knowledge of using HIS (7)	*					*					*	*	*		*	*	
	Lack of experience using HIS (4)	*										*	*					*
	Lack of computer literacy (4)	*		*				*					*					
	Low numbers of health informatics/Specialists/shortage of professionals (7)	*	*			*	*						*			*		*
	High initial cost /switching cost/ Lack of financial support (7)	*	*	*			*		*							*	*	
	High operation and maintenance costs	*																
	National Healthcare System/ lack of national infomration standards/ Lack of a National Plan for Medical Data Exchange (5)		*	*	*		*							*				
	Lack of policies/ procedures in hospital level. (5)	*	*		*		*		*									
	EMRs implementation took more than expected time/time consuming (4)	*							*	*			*					
	Lack of time allowed to learn and train on using HIS/ time barriers (3)	*		*													*	
	No strategic planning/Lack of an Information Management Plan (6)	*	*				*	*	*							*		
	Lack of Clinicians ’ Engagement/ connection and collabration (5)		*	*			*	*							*			
	Resistance to change/ Resistance to using new technologies (10)		*			*	*	*	*			*	*	*			*	*
	unsatisfied training programmes/ lack of training (10)	*		*	*	*	*	*	*	*	*							*

	Lack of hospital leadership support/Lack of healthcare professionals' support to HIS(6)	*				*			*	*	*				*			*
	The absence of a National Regulator (3)	*	*										*					
	language issues (3)						*						*			*		
	Lack of motivation to learn and train on using HIS	*																
	HIS add more work/need more time/effort	*																
	Negative beliefs about their ability to use HIS	*																
	HIS slow down work/decreases productivity (3)	*	*											*				
	Lack of automation to support change																	*
Semanti	Workflow needs redesign to match with EMRs (1)	*																
	Mapping issues (3)		*	*			*											
	HIS modules are not fully integrated (1)	*																
Technical Barriers	No manuals or guidelines for using HIS	*																
	There are no standards for data entry or retrieval/ the lack of a standardized system (6)	*	*				*					*	*	*				
	Computers and networks have a lot of maintenance problems/Inadequate IT support and maintenance (7)	*		*				*	*	*	*	*						
	The computer terminals are old and slow/ IT infrustructure/ poor quality of ICT infrastructure (6)	*	*	*			*		*								*	
	Communication networks are slow	*																
	HIS are not satisfying different users' needs (3)	*						*			*							
	The main difficulty with EMRs is data entry/Additional time for data entry (3)	*		*							*							
	The system's interface design is not user friendly/understandable	*		*														
	EMRs are difficult to use because they are very complicated/ complexity of the system (7)	*	*	*							*	*	*				*	
	There are not enough computer terminals																	
	Market Uncertainties/Instability of EHR vendor (4)		*		*							*	*					
	Design and implementation/ poor IT design and planning (5)			*				*	*	*						*		
	lack of clear pricing between government, companies and individuals				*													

	the user interface language is difficult or not clear	*																
	Security and confidentiality/privacy concerns (7)	*		*			*	*			*	*		*				

Table A-3 Number and reference (above table)

No.	Reference
1	(Khalifa, 2013)
2	(Alkraiji, Jackson and Murray, 2013)
3	(Khudair, 2008)
4	(Mourshed, Hediger and Lambert, 2006)
5	(Alsultan *et al.*, 2012)
6	(Al-Shorbaji, 2008)
7	(Mogli, 2012)
8	(Zaher, 2012)
9	(Al-Harbi, 2011)
10	(El Mahalli, 2015)
11	(Hasanain and Cooper, 2014)
12	(Hasanain, Vallmuur and Clark, 2014)
13	(Altuwaijri, 2008)
14	(Saddik and Al-Fridan, 2012)
15	(Wahabi and Alziedan, 2012)
16	(El-Mahalli, El-Khafif and Al-Qahtani, 2012)
17	(Alsultan *et al.*, 2013)

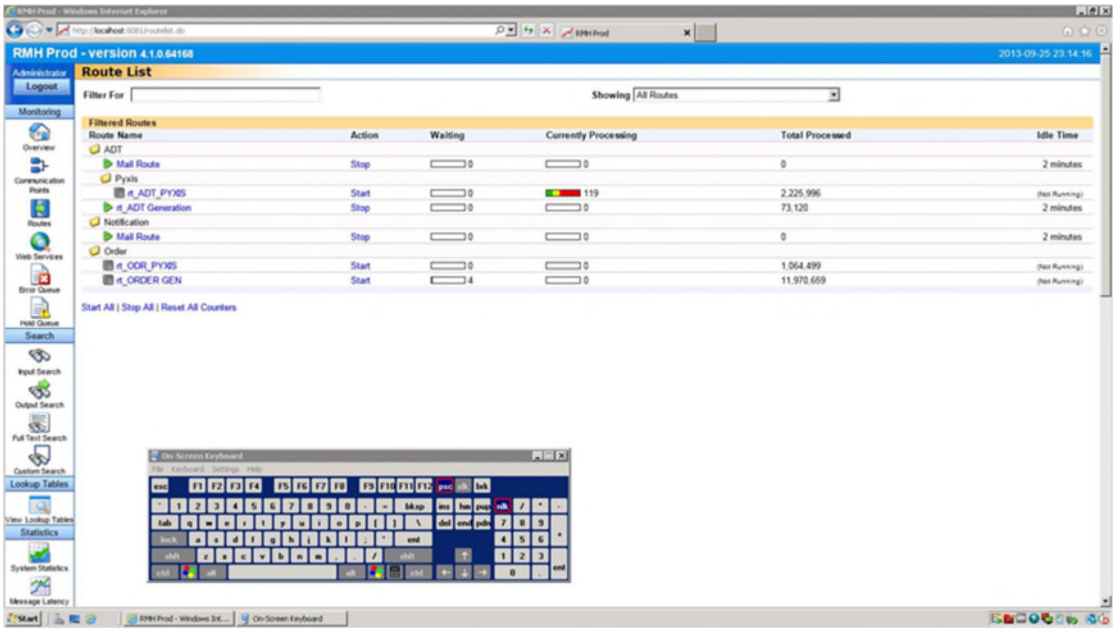


Figure A-1 Snapshot from Rhapsody (main screen)

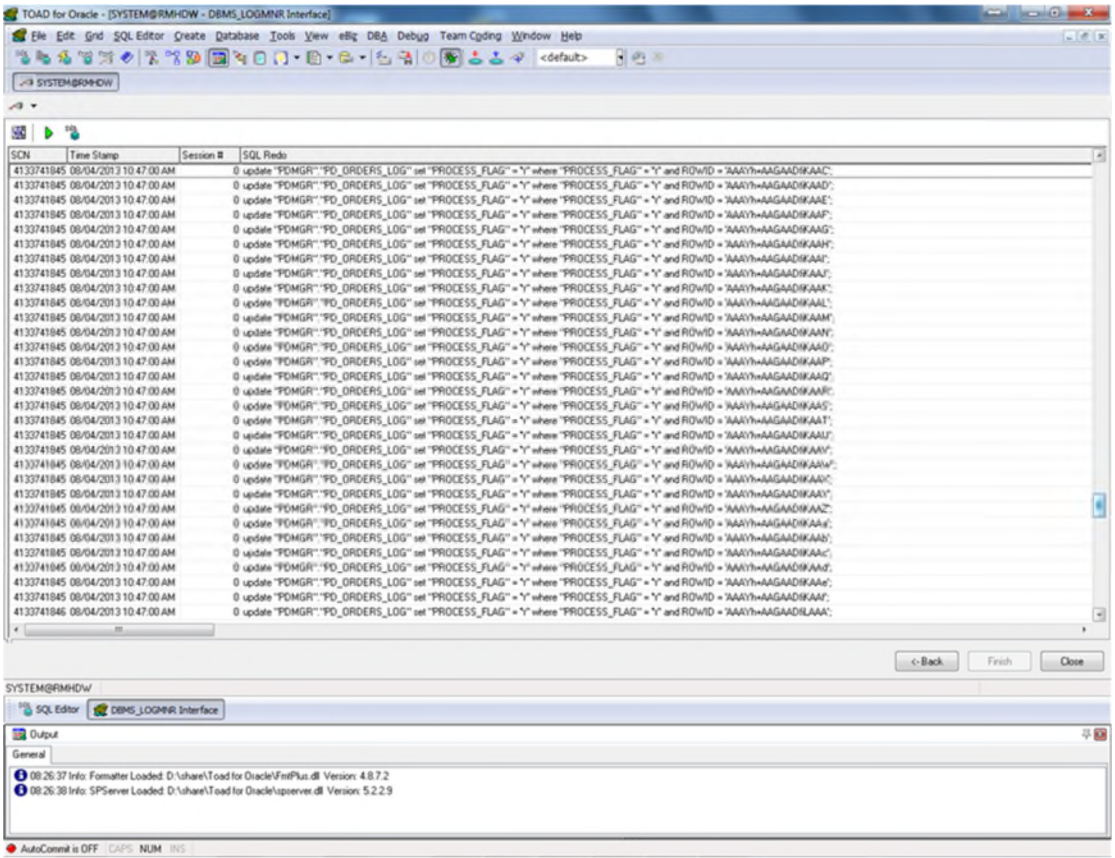


Figure A-2 Oracle database hanged

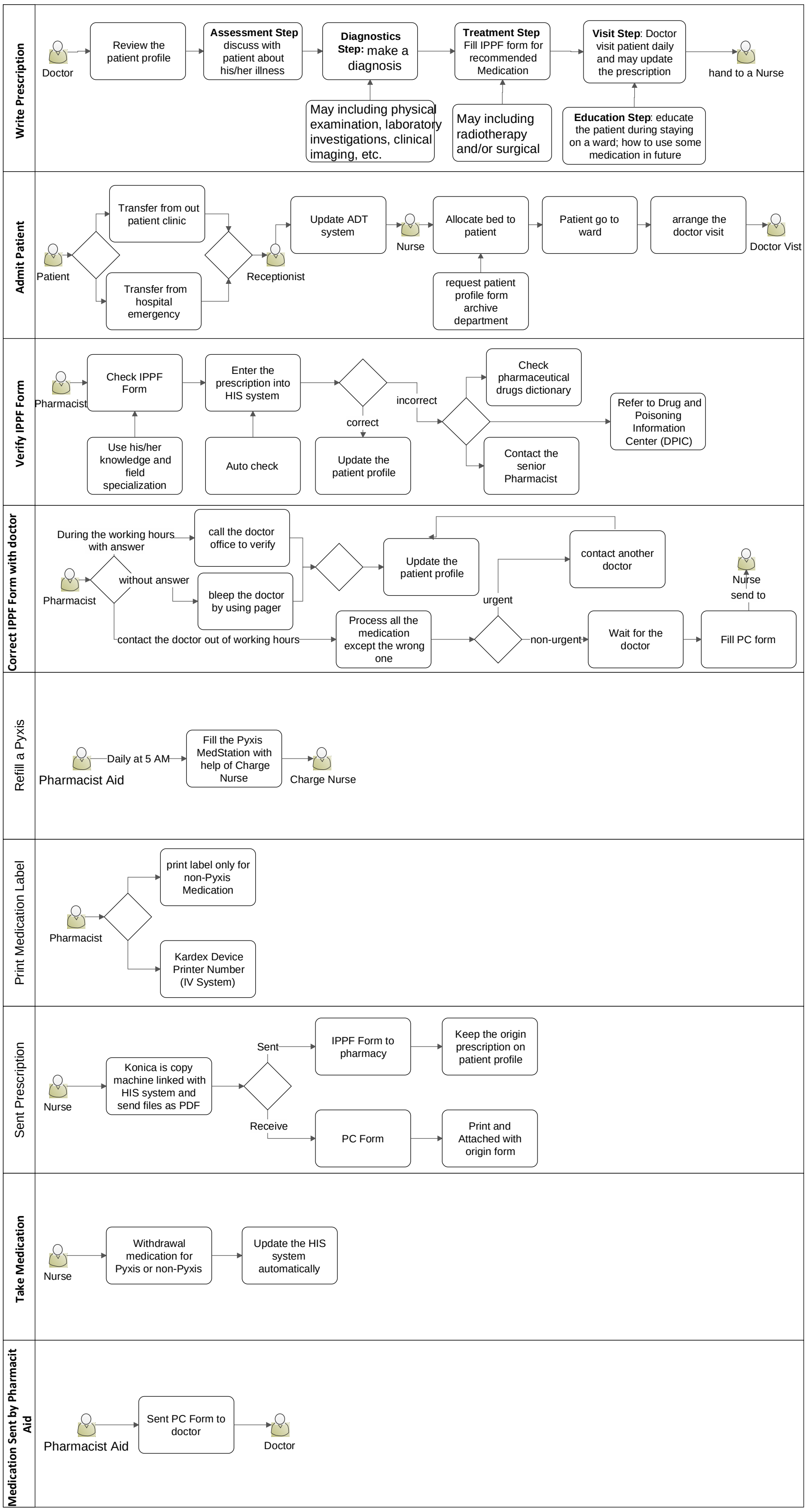


Figure A-3 Action-BPMN

Table A-4 The documents collection

No.	Document name	Source
E-mail Correspondence		
1	Rhapsody Failure/ Rhapsody server error for sending orders in Pyxis	Pharmacy
2	Medication timing or interval dosing is not showing to alert the staff of what is the due medication in certain time	Pharmacy
3	No communication with Rhapsody after updating Oracle, Oracle continuously sending update request to database and the database got hanged as well as it slowing Rhapsody	
4	Error - Rhapsody not receiving ADT	IT
5	Mapping IV orders to create rhapsody HL7 message file	IT
6	Not receiving any order from the rhapsody need to power shutdown server to work	IT
Future Plans		
7	Presentation for automation inpatient pharmacy (e.g. Cytotoxic Automation, Robotics Filling and IV Automation).	Pharmacy
Documents		
8	Quick Guide (Procedures of reporting Pyxis problem)	Nurse
9	Copy from pharmacy data workflow diagram	IT
Website		
10	Inpatient pharm website	
Web Documents		
11	Tutorial for using Pyxis	YouTube

Appendix B CPR System Implementation - Figures and Table

Prince Sultan Military Medical City
Information & Communication Technology Department
Pharmaceutical Services and Nursing Department

مدينة الامير سلطان الطبية العسكرية
ادارة تقنية الاتصالات والمعلومات
ادارة الخدمات الصيدلية وادارة التمريض

PSMMC

Paediatric CPR Card

Patient Details

Medical Record No.:	Name:	Sex :
Date of Birth:	Age:	Weight:

DRUGS (IV Route)	**Concentration**	**Dose /Kg**	**Dose ml/kg**	**Final dose**
Adrenaline Inj 1:10,000	0.1 mg/ml	10 mcg/kg	0.1 ml/kg	=
Atropine Sulphate	600 mcg/ml	20 mcg/kg	0.033 ml/kg	=
Atropine Sulphate	100 mcg/ml	20 mcg/kg	0.2 ml/kg	=
Calcium Chloride Inj 10%	100 mg/ml	20 mg/kg	0.2 ml/kg	=
Sodium Bicarbonate 8.4%	1 mEq/ml	1 mEq/kg	1 ml/kg	=
Sodium Bicarbonate 4.2%	0.5 mEq/ml	1 mEq/kg	2 ml/kg	=
Normal Saline	0.9% Nacl.	20mls/kg	20 ml/kg	=
ANTIARRHYTHMIC				
Amiodarone	50mg/ml	5mg/kg	0.1 ml/kg	=
ANTIDOTE				
Flumazenil	100 mg/ml	5 mcg/kg	0.05 ml/kg	=
Naloxone HCl (Narcan)	0.4 mg/ml	0.1 mg/kg	0.25 ml/kg	=
DRUGS (ET Route)	**Concentration**	**Dose /Kg**	**Dose ml/kg**	**Final dose**
Adrenaline Inj 1:1,000	1mg/ml	100 mcg/kg	0.1 ml/kg	=
Atropine	600 mcg/ml	40-60 mcg/kg	0.07-0.1 ml/kg	=
Atropine	500 mcg/ml	40-60 mcg/kg	0.08-0.12 ml/kg	=
Naloxone HCl (Narcan)	0.4 mg/ml	0.1 mg/kg	0.25 ml/kg	=
CARDIOVERSION	Initial dose		0.5 -1 Joules/kg	=
	Subsequent dose		2 Joules/kg	=
DEFIBRILLATION	Initial dose		2 Joules/kg	=
	Subsequent dose		4,6,8,10 Joules/kg	=
SEDATIONS	**Concentration**	**Dose /Kg**	**Dose ml/kg**	**Final dose**
Midazolam	5mg/ml	0.1mg/kg	0.02 ml/kg	=
Fentanyl	50 mcg/ml	1 mcg/kg	0.02 ml/kg	=
Ketamine	50mg/ml	1 mg/kg	0.02 ml/kg	=
PARALYZING AGENT				
Cisatracurium	5mg/ml	0.1mg/kg	0.02 ml/kg	=
Cisatracurium	2 mg/ml	0.1 mg/kg	0.05 ml/kg	
Propofol	20 mg/ml	3 mg/kg	0.15 ml/kg	=
Propofol	10 mg/ml	3 mg/kg	0.3 ml/kg	=
Suxamethonium	50mg/ml	1 mg/kg	0.02 ml/kg	=

ETT size:		Lip Level:		Trach size:	
Suction catheter size:		Suction catheter at:			
Signed by:					
Doctor:				Date:	

CPR Card/I&CT....

Figure B-1 The generated CPR form using the CPR medications software

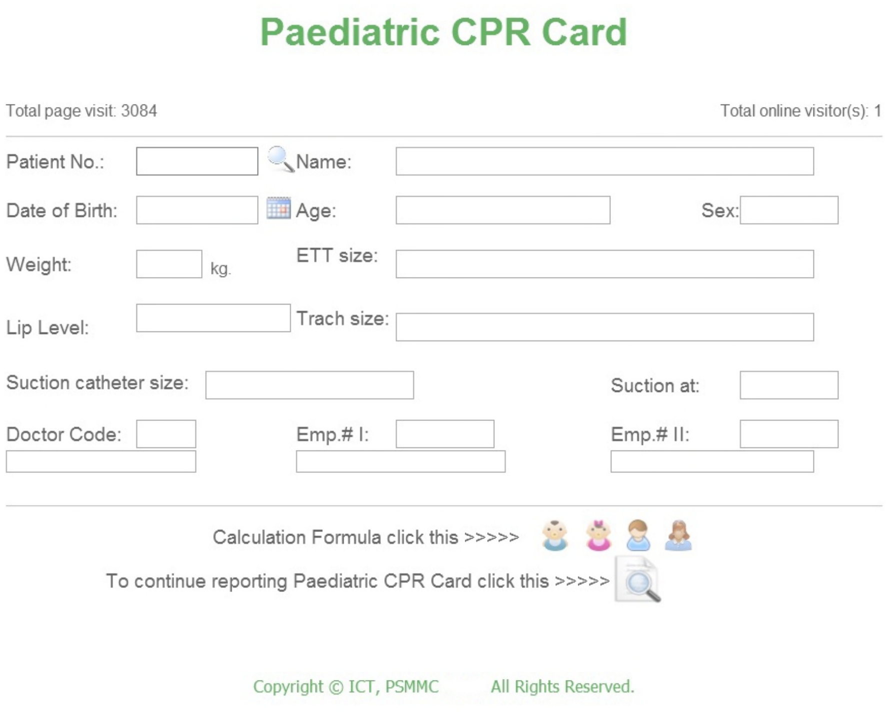


Figure B-2 Loging screen

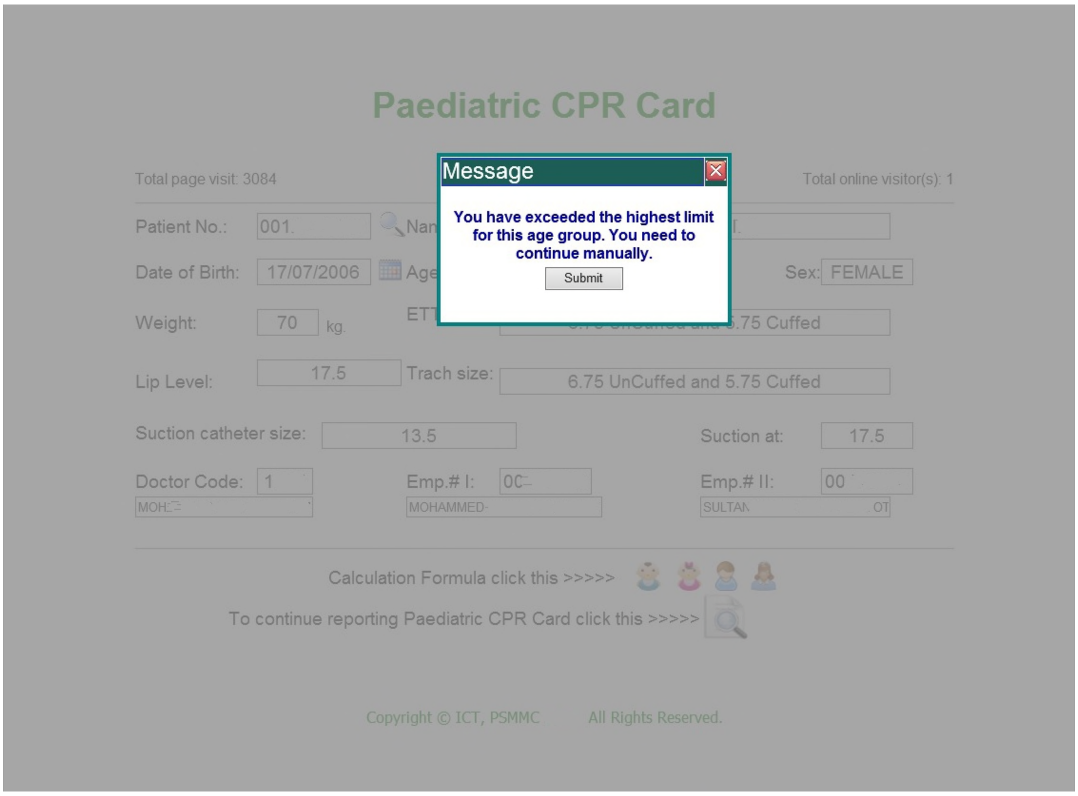


Figure B-3 Hard upper limit message

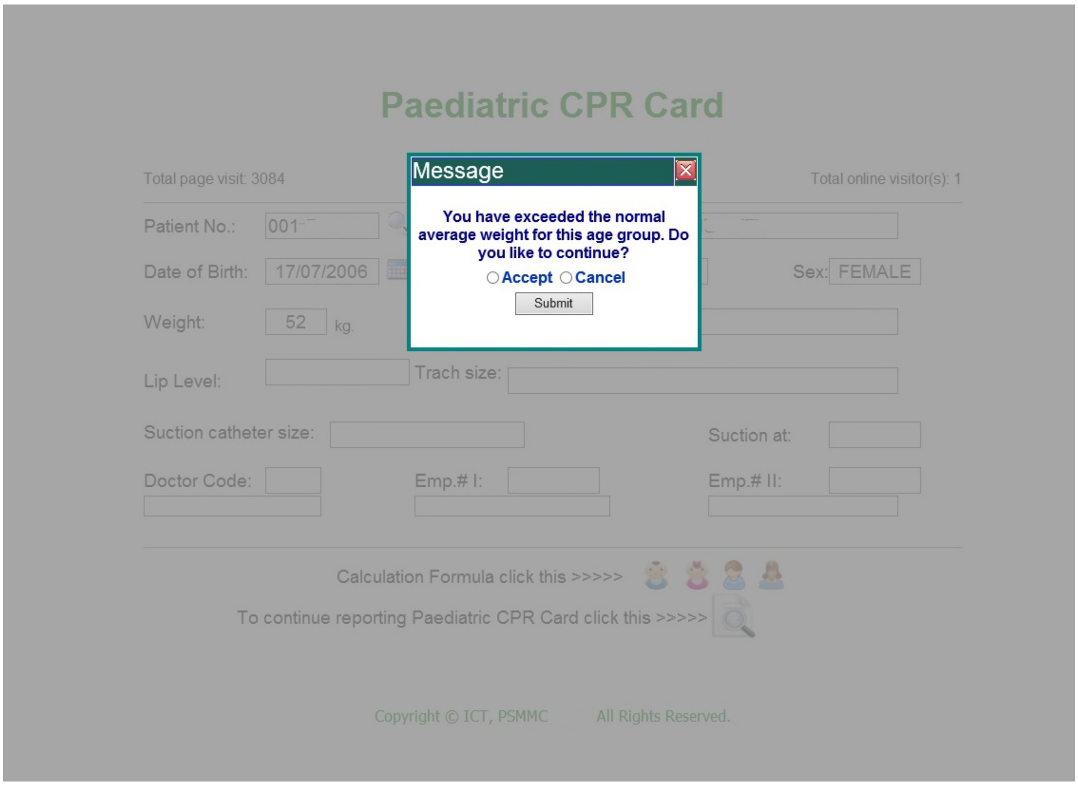


Figure B-4 Hard Lower limit message

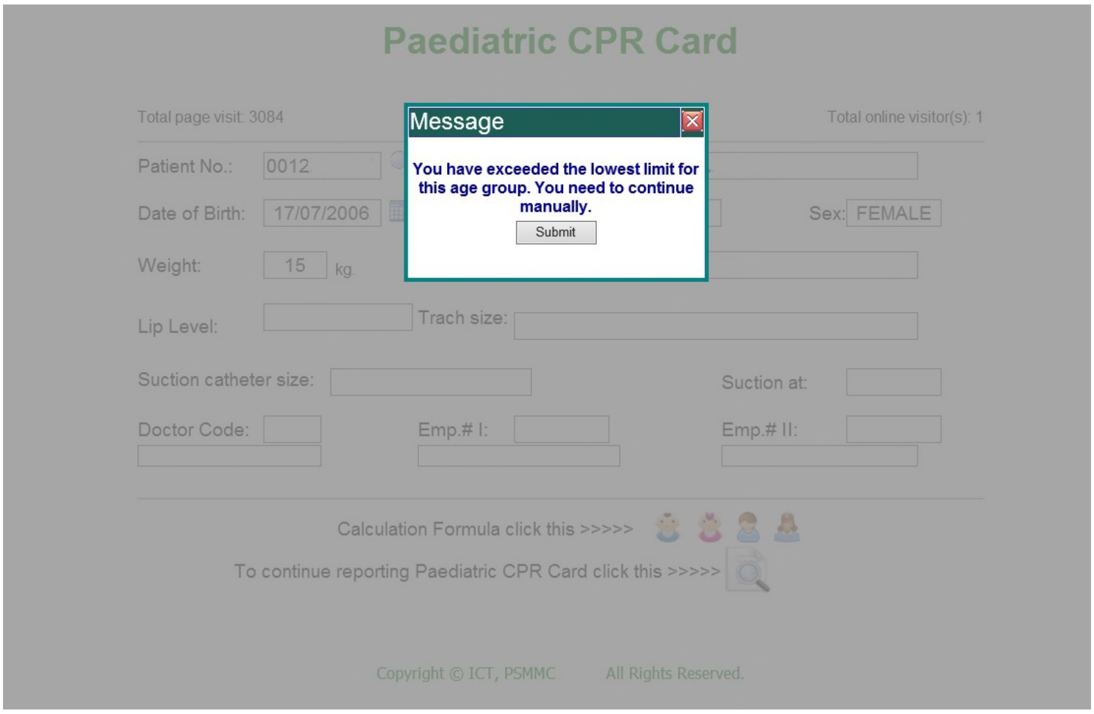


Figure B-5 Soft upper limit message

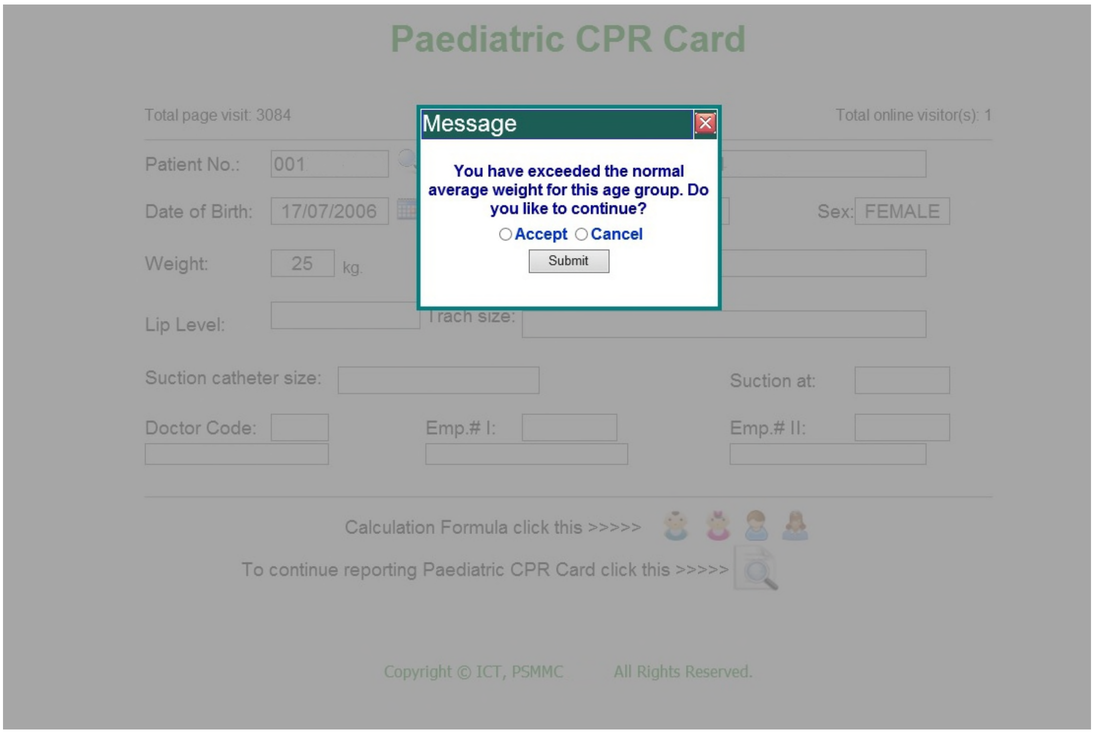


Figure B-6 Soft Lower limit message

Table B-1 Lower hard, lower soft, upper soft and upper hard limits for boys age from 2-12 years

Boys (2 years- 12 years)					
Years	**LHL**	**LSL**	**Average**	**USL**	**UHL**
2	6.78	10.17	13.56	16.96	20.35
3	**7.67**	**11.50**	**15.33**	**19.16**	**23.00**
4	8.69	13.04	17.39	21.73	26.08
5	**9.81**	**14.72**	**19.62**	**24.53**	**29.44**
6	10.98	16.47	21.96	27.45	32.94
7	**12.22**	**18.33**	**24.44**	**30.54**	**36.65**
8	13.59	20.38	27.18	33.97	40.77
9	**15.17**	**22.75**	**30.34**	**37.92**	**45.50**
10	17.01	25.52	34.02	42.53	51.04
11	**19.35**	**29.03**	**38.70**	**48.38**	**58.06**
12	20.34	30.51	40.67	50.84	61.01
13	**24.03**	**43.74**	**48.06**	**53.15**	**72.10**
14	36.22	46.49	51.00	56.29	79.01

Note: LHL: Lower Hard Limit, LSL: Lower Soft Limit, USL: Upper Soft Limit and UHL: Upper Hard Limit

Table B-2 Lower hard, lower soft, upper soft and upper hard limits for girls age from 2 to 12 years

Girls (2 years-12years)					
Years	**LHL**	**LSL**	**Average**	**USL**	**UHL**
2	6.52	9.78	13.04	16.30	19.56
3	7.44	11.17	14.89	18.61	22.33
4	8.47	12.70	16.93	21.17	25.40
5	9.58	14.37	19.16	23.96	28.75
6	10.79	16.18	21.58	26.97	32.37
7	12.14	18.20	24.27	30.34	36.41
8	13.70	20.55	27.40	34.25	41.10
9	15.53	23.29	31.06	38.82	46.59
10	17.60	26.40	35.20	44.00	52.80
11	19.81	29.71	39.62	49.52	59.42
12	20.91	31.37	41.83	52.28	62.74
13	23.75	43.31	47.51	53.61	71.26
14	35.99	45.12	49.36	54.54	80.48

Table B-3 Lower hard, lower soft, upper soft and upper hard limits for infant girls age from 0 to 23 months

	Weight in (kg)				
Age months	LHL	LSL	Average	USL	UHL
0	1.60	2.40	3.2	4	4.8
1	2.10	3.15	4.2	5.25	6.3
2	2.55	3.83	5.1	6.375	7.65
3	2.90	4.35	5.8	7.25	8.7
4	3.20	4.80	6.4	8	9.6
5	3.45	5.18	6.9	8.625	10.35
6	3.65	5.48	7.3	9.125	10.95
7	3.80	5.70	7.6	9.5	11.4
8	3.95	5.93	7.9	9.875	11.85
9	4.10	6.15	8.2	10.25	12.3

10	4.25	6.38	8.5	10.625	12.75
11	4.35	6.53	8.7	10.875	13.05
12	4.45	6.68	8.9	11.125	13.35
13	4.60	6.90	9.2	11.5	13.8
14	4.70	7.05	9.4	11.75	14.1
15	4.80	7.20	9.6	12	14.4
16	4.90	7.35	9.8	12.25	14.7
17	5.00	7.50	10	12.5	15
18	5.10	7.65	10.2	12.75	15.3
19	5.20	7.80	10.4	13	15.6
20	5.30	7.95	10.6	13.25	15.9
21	5.45	8.18	10.9	13.625	16.35
22	5.55	8.33	11.1	13.875	16.65
23	5.65	8.48	11.3	14.125	16.95

Table B-4 Lower hard, lower soft, upper soft and upper hard limits for infant boys age from 0 to 23 months

	Weight in (kg)				
Age months	LHL	LSL	Average	USL	UHL
Preterm	1.10	1.65	2.2	2.75	3.3
0	1.65	2.48	3.3	4.125	4.95
1	2.25	3.38	4.5	5.625	6.75
2	2.80	4.20	5.6	7	8.4
3	3.20	4.80	6.4	8	9.6
4	3.45	5.18	6.9	8.625	10.35
5	3.75	5.63	7.5	9.375	11.25
6	3.95	5.93	7.9	9.875	11.85
7	4.15	6.23	8.3	10.375	12.45
8	4.30	6.45	8.6	10.75	12.9
9	4.45	6.68	8.9	11.125	13.35
10	4.60	6.90	9.2	11.5	13.8
11	4.70	7.05	9.4	11.75	14.1
12	4.80	7.20	9.6	12	14.4
13	4.95	7.43	9.9	12.375	14.85
14	5.05	7.58	10.1	12.625	15.15
15	5.15	7.73	10.3	12.875	15.45
16	5.25	7.88	10.5	13.125	15.75
17	5.35	8.03	10.7	13.375	16.05
18	5.45	8.18	10.9	13.625	16.35
19	5.55	8.33	11.1	13.875	16.65
20	5.65	8.48	11.3	14.125	16.95
21	5.75	8.63	11.5	14.375	17.25
22	5.90	8.85	11.8	14.75	17.7
23	6.00	9.00	12	15	18

Table B-5 Experiment test results

No	Calculation	Check	Total Time	Profiling	Manual errors	Score	Manual	System
1	00:05:45	00:01:35	00:07:20	00:00:40	2	92%	Yes	No
2	00:05:45	00:01:52	00:07:37	00:00:52	3	88%	Yes	No
3	00:08:16	00:03:10	00:11:26	00:01:30	8	68%	Yes	No
4	00:05:05	00:01:05	00:06:10	00:01:02	0	100%	No	No
5	00:04:55	00:00:45	00:05:40	00:00:35	2	92%	Yes	No

6	00:04:44	00:01:29	00:06:13	00:01:20	2	92%	Yes	No
7	00:04:51	00:01:50	00:06:41	00:00:50	3	88%	Yes	No
8	00:04:40	00:01:00	00:05:40	00:01:10	2	92%	Yes	No
9	00:05:00	00:01:29	00:06:29	00:02:30	6	76%	Yes	No
10	00:04:40	00:01:35	00:06:15	00:01:00	3	88%	Yes	No
11	00:05:05	00:01:05	00:06:10	00:01:50	2	92%	Yes	No
12	00:05:27	00:01:15	00:06:42	00:01:02	2	92%	Yes	No
13	00:04:41	00:02:05	00:06:46	00:01:00	11	56%	Yes	No
14	00:05:05	00:01:09	00:06:14	00:00:50	0	100%	No	No
15	00:04:47	00:00:45	00:05:32	00:00:52	2	92%	Yes	No
16	00:05:59	00:00:50	00:06:49	00:00:56	2	92%	Yes	No
17	00:04:52	00:00:48	00:05:40	00:01:00	2	92%	Yes	No
18	00:04:15	00:01:05	00:05:20	00:01:09	0	100%	No	No
19	00:05:10	00:01:20	00:06:30	00:00:41	0	100%	No	No
20	00:06:15	00:02:24	00:08:39	00:01:20	0	100%	No	No
21	00:04:25	00:02:00	00:06:25	00:01:34	0	100%	No	No
22	00:05:10	00:02:05	00:07:15	00:00:47	0	100%	No	No
23	00:05:27	00:02:25	00:07:52	00:02:13	0	100%	No	No
24	00:08:25	00:01:20	00:09:45	00:00:50	0	100%	No	No
25	00:05:04	00:01:30	00:06:34	00:01:09	0	100%	No	No
26	00:06:00	00:03:09	00:09:09	00:01:08	0	100%	No	No
27	00:06:00	00:03:00	00:09:00	00:00:49	0	100%	No	No
28	00:07:00	00:04:00	00:11:00	00:01:03	0	100%	No	No
29	00:10:00	00:02:00	00:12:00	00:01:02	0	100%	No	No
30	00:07:00	00:04:04	00:11:04	00:01:05	0	100%	No	No
31	00:04:02	00:01:00	00:05:02	00:00:58	0	100%	No	No
32	00:04:25	00:02:00	00:06:25	00:01:34	0	100%	No	No
33	00:05:10	00:02:05	00:07:15	00:00:47	0	100%	No	No
34	00:05:27	00:02:25	00:07:52	00:02:13	0	100%	No	No
35	00:08:25	00:01:20	00:09:45	00:00:50	0	100%	No	No
36	00:05:04	00:01:30	00:06:34	00:01:09	0	100%	No	No
37	00:06:00	00:03:09	00:09:09	00:01:08	0	100%	No	No
38	00:06:00	00:03:00	00:09:00	00:00:49	0	100%	No	No
39	00:07:00	00:04:00	00:11:00	00:01:03	0	100%	No	No
40	00:10:00	00:02:00	00:12:00	00:01:02	0	100%	No	No
41	00:07:00	00:04:04	00:11:04	00:01:05	0	100%	No	No
42	00:04:02	00:01:00	00:05:02	00:00:58	0	100%	No	No
43	00:04:53	00:01:28	00:06:21	00:01:34	0	100%	No	No
44	00:04:16	00:01:47	00:06:03	00:00:45	0	100%	No	No
45	00:06:04	00:01:00	00:07:04	00:01:05	0	100%	No	No

46	00:06:00	00:01:00	00:07:00	00:00:45	0	100%	No	No
47	00:05:36	00:02:00	00:07:36	00:01:40	0	100%	No	No
48	00:10:00	00:02:00	00:12:00	00:00:58	0	100%	No	No
49	00:05:00	00:01:00	00:06:00	00:01:19	0	100%	No	No
50	00:06:00	00:03:00	00:09:00	00:01:34	0	100%	No	No
51	00:07:00	00:02:00	00:09:00	00:01:20	0	100%	No	No
52	00:09:00	00:01:58	00:10:58	00:00:56	0	100%	No	No
53	00:05:43	00:01:20	00:07:03	00:00:49	0	100%	No	No
54	00:04:00	00:02:00	00:06:00	00:01:17	0	100%	No	No
55	00:05:41	00:01:42	00:07:23	00:01:12	0	100%	No	No
56	00:04:53	00:01:17	00:06:10	00:00:59	0	100%	No	No
57	00:05:46	00:01:57	00:07:43	00:01:01	0	100%	No	No
58	00:07:41	00:05:35	00:13:16	00:04:50	0	100%	No	No
59	00:07:29	00:04:58	00:12:27	00:04:58	1	96%	Yes	No
60	00:07:01	00:05:06	00:12:07	00:01:00	0	100%	No	No
61	00:09:39	00:05:04	00:14:43	00:01:02	9	64%	Yes	No
62	00:07:37	00:06:21	00:13:58	00:00:47	12	52%	Yes	No
63	00:04:40	00:05:11	00:09:51	00:01:00	4	84%	Yes	No
64	00:05:47	00:04:19	00:10:06	00:01:36	2	92%	Yes	No
65	00:02:55	00:02:53	00:05:48	00:00:41	1	96%	Yes	No
66	00:11:41	00:04:11	00:15:52	00:02:05	3	88%	Yes	No
67	00:07:06	00:10:55	00:18:01	00:00:53	17	32%	Yes	No
68	00:06:58	00:04:31	00:11:29	00:01:17	0	100%	No	No
69	00:04:00	00:05:05	00:09:05	00:01:13	0	100%	No	No
70	00:05:47	00:04:23	00:10:10	00:01:47	0	100%	No	No
Total	07:00:36	02:55:43	09:56:19		101			
Mean	00:06:01	00:02:31	00:08:31	00:01:15	1.44	94%	23	0
Max	00:11:41	00:10:55	00:18:01	00:04:58	17.00	100%	Count of errors	
Min	00:02:55	00:00:45	00:05:02	00:00:35	0.00	32%		

Appendix C Nural System Implementation - Figures and Tables

Table C-1 Analysis of telephone call duration (minutes) prior and after implementation

	Number		
Type	Before	After	P value
Confirmation	40	9	> 0.001
Follow-up	112	56	> 0.001
IV discontinuations	1	6	0.02
Missing dose	14	19	0.2
PRN medications	13	19	0.05
Professional inquiries	21	116	> 0.001
Other	79	62	0.03
(Blank)	16	13	
Grand Total	296	300	

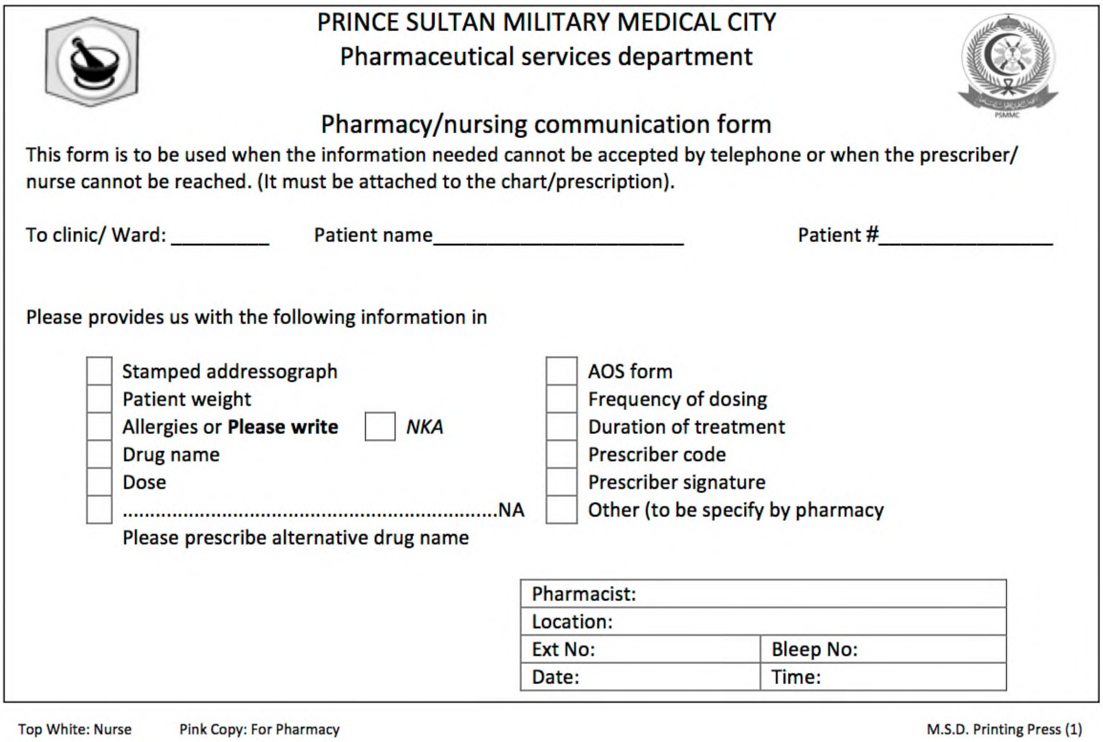
Analysis of phone calls received from nursing by inpatient pharmacy department.

Date:

Location: ☐ IP IV Building 5 ☐ IP Oral Building 5 ☐ IP IV Building 2 ☐ IP Oral Building 2 ☐ ED IV Pharmacy ☐ ED Oral Pharmacy

		Type of call										
Time	Ward	Conf	Follow-up	Time received	Type of Rx (S,A,R)	Refill medications	Missing dose	IV D/C	Professional inquiries	Wrong profiling	Other	Specify

Figure C-1 Data collection form



PRINCE SULTAN MILITARY MEDICAL CITY
Pharmaceutical services department

Pharmacy/nursing communication form

This form is to be used when the information needed cannot be accepted by telephone or when the prescriber/ nurse cannot be reached. (It must be attached to the chart/prescription).

To clinic/ Ward: _________ Patient name______________________ Patient #_______________

Please provides us with the following information in

- ☐ Stamped addressograph
- ☐ Patient weight
- ☐ Allergies or **Please write** ☐ *NKA*
- ☐ Drug name
- ☐ Dose
- ☐ ....NA
- Please prescribe alternative drug name
- ☐ AOS form
- ☐ Frequency of dosing
- ☐ Duration of treatment
- ☐ Prescriber code
- ☐ Prescriber signature
- ☐ Other (to be specify by pharmacy

Pharmacist:	
Location:	
Ext No:	Bleep No:
Date:	Time:

Top White: Nurse Pink Copy: For Pharmacy M.S.D. Printing Press (1)

Figure C-2 Pharmacy nursing communication

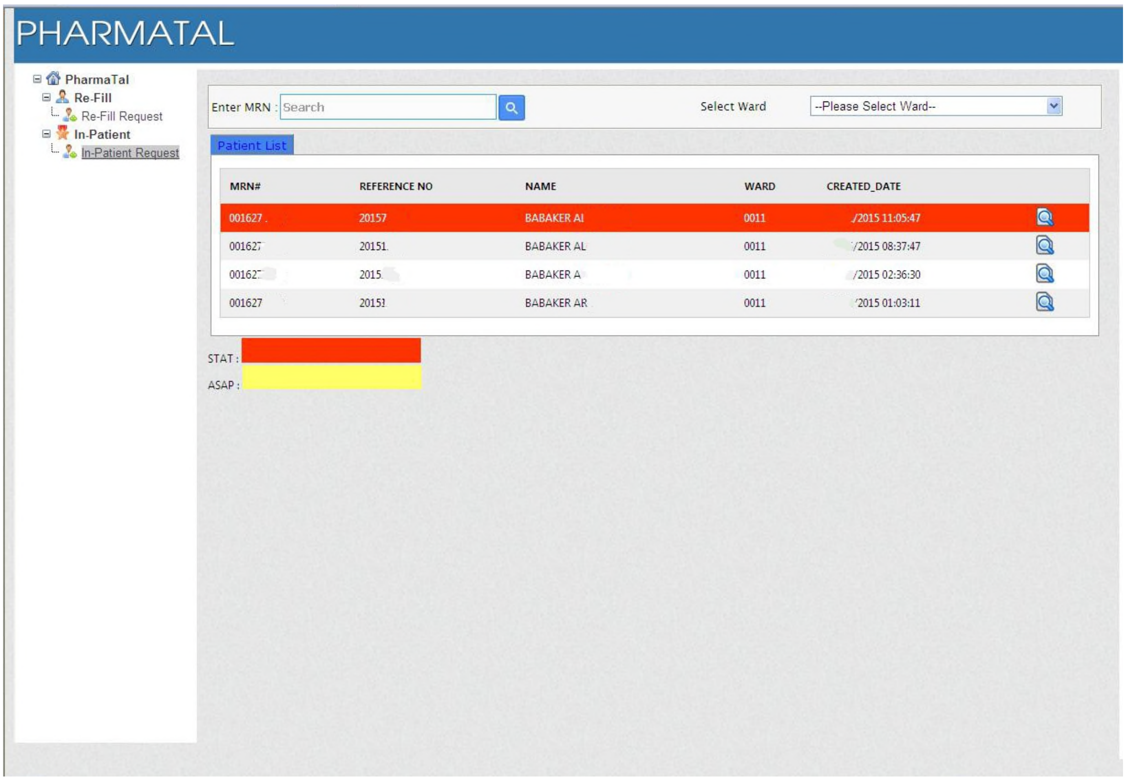


Figure C-3 Patient list sorted according to the priority colour coding, with red for STAT and yellow for ASAP medications

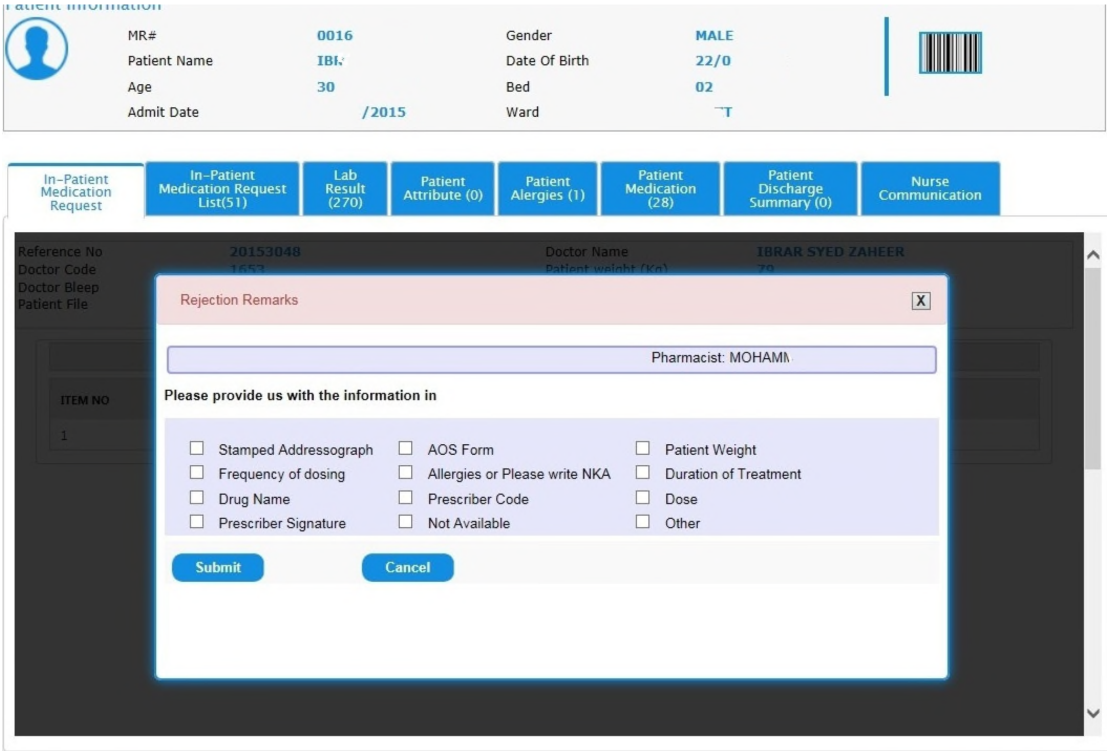


Figure C-4 The electronic pharmacy nursing communication form

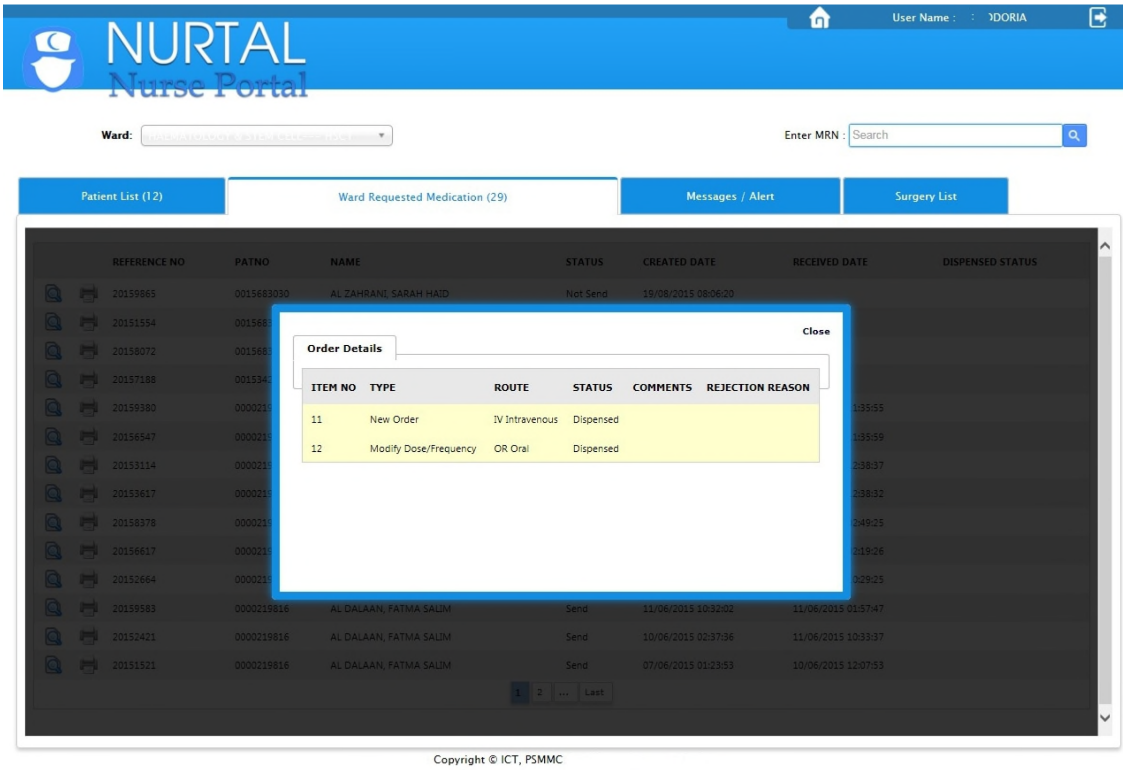


Figure C-5 The pop-up screen that shows the request status

Appendix D CPR System Questionnaire

Dear participants,

I am writing to ask for your collaboration with this research project. This study requires the use of a questionnaire to understand the acceptance of Cardiopulmonary resuscitation (CPR) system within work environments amongst nursing workforce at Prince Sultan Military Medical City (PSMMC). I would like to invite you to consider participating in a research study by **completing an anonymous questionnaire**. Your participation is entirely voluntary. Therefore, I hope that you will feel comfortable about giving me your honest opinions. You are invited to read the information provided which will tell you about why the study is being conducted and what it would mean if you decided to take part. Your assistance to the research will be provided by your answering the enclosed questionnaire. The success of this research is highly dependent on your participation. There is no wrong or right answer; your honest answer is what matters. You might find some similarities among some questions; however, they are different cases for the researcher.

The study will take **approximately 8 minutes** to complete. You are free to withdraw your participation at any time.

Your participation in this study will be highly appreciated.

Sincerely,

The researchers

Participant Information Sheet

Study Title: Reduce the time and potential errors in CPR medications using a CPR calculator in paediatric wards.

Ethics approval number: 776

Please read this information carefully before deciding whether or not to take part in this research.

What is the research about?

The purpose of this study is to evaluate the impact of a CPR system on the frequency of errors in CPR medications and the time to prepare the CPR card, in a paediatric wards. The researcher requests your assistance with this study, which aims to help to ensure the quality and safety of nursing care in the Kingdom of Saudi Arabia.

Why have I been chosen?

You are being asked whether you would like to participate in this study because you are a registered nurses and you are involved in using CPR system.

What will happen to me if I take part?

If you decide to participate you will answer some questions about using CPR system in the PSMMC. It should take approximately 5 minutes to complete the questionnaire.

Are there any benefits in my taking part?

No payment will be made for participation or in compensation for any time lost.

Are there any risks involved?

There are no risks attached to your participation in this study.

Will my participation be confidential?

This project is committed to, and will abide by, the terms of the research and ethic committee policy. All the information collected by the researcher for the study will be kept confidential and will be stored in accordance with strict privacy protection procedures. The results of this study will not contain personal identifying information (i.e. the data will be anonymous). All data will be kept securely in a password-protected form by the researcher, and only others who are involved in the data analysis will be eligible to access the data.

What happens if I change my mind?

You have the right to participate or not, and you will be able to withdraw from the research at any time without giving a reason and without any consequences, even after you have agreed to take part.

What happens if something goes wrong?

If you wish to make a complaint for any reason, if you have any concerns regarding any aspect of your involvement or if you feel that you have been placed at risk, please contact the Chair of the research and ethic Committee at the PSMMC, email: REC-PSMMC@psmmc.med.sa or telephone No: (966) 11 4777714 ext. 40062 telephone No, Saudi Arabia.

Where can I get more information?

If you have any questions or need more information related to this study, please feel free to contact the following:

1. Dr. Ahmed Al-Yami, Nursing Consultant and Director of Nursing Quality, PSMMC. Telephone number: +966502240404. email: amalyami@psmmc.med.sa
2. Dr Mohammed Almeziny, Head of inpatient pharmacy, PSMMC, Bleep 0242. email almuzaini@psmmc.med.sa.
3. Saleh Binobaid, PhD Student at Cranfield University, United Kingdom, s.a.binobaid@cranfield.ac.uk.

Instructions:

The questionnaire is designed to measure your perceptions toward using CPR system. You will be asked questions which make use of rating scales with seven places. Next to each question is a seven-point rating scale. You need to circle a number in the place on the scale that best describes your opinion. For example, if you were asked to rate the statement " The weather in Riyadh" on such a scale, the seven-point rating scale would be interpreted as follows:

Bad:___1___:___2__:____3____:___4____:___5___:___6___:___7___:Good
extremely quite slightly neither slightly quite extremely

If you think the weather in Riyadh is quite good, then you would circle the number 6, as follows:

The weather in Riyadh is	1	2	3	4	5	6	7

If you think the weather in Riyadh is extremely bad, then you would circle the number 1, as follows:

The weather in Riyadh is	1	2	3	4	5	6	7

Do not circle more than one answer

The weather in Riyadh is	1	2	3	4	5	6	7

Questionnaire:

Part I: Demographic data:

The questionnaire is anonymous; this means it will not be possible to identify you or link any responses to you. Please circle the most appropriate number of each statement which corresponds most closely to your desired response.

1. **Age:**

   ☐ 20-30 years ☐ 31-40 years ☐ 41-50 years ☐ >51 years

2. **Gender:** ☐ Male ☐ Female

3. **Nationality:** ☐ Saudi ☐ Non-Saudi, specify______________

4. **Years of experience:**

   ☐ Less than 1 Year ☐ 1-2 Years

   ☐ 3-5 Years ☐ More than 5 Years

5. **Level of education:**

   ☐ Master in Nursing ☐ Doctor in Nursing

   ☐ Diploma in Nursing ☐ Bachelor in Nursing

6. **Job title:**

   ☐ Charge Nurse ☐ Nursing Team

   ☐ Staff Nurse 1 ☐ Staff Nurse 2

Part II: TAM 3

Please, indicate your level of agreement with the following statements, where 1 is extremely disagree and 7 is extremely agree (put one ✓ in each line). Some of questions may appear similar, but there are actually subtle differences in what is being asked. Your opinions and perceptions are valued.

	Strongly Disagree	Moderately Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Moderately Agree	Strongly Agree
Comparing the manual calculation, CPR system reduces the time needed to complete CPR card	1	2	3	4	5	6	7
CPR system reduces the chance of calculation errors	1	2	3	4	5	6	7
CPR system reduces the chance of data entry errors	1	2	3	4	5	6	7
Using CPR system is better than the old process/system	1	2	3	4	5	6	7
I find the CPR system to be useful.	1	2	3	4	5	6	7
Information display is clear and understandable.	1	2	3	4	5	6	7
The CPR system data entry is easy and visible	1	2	3	4	5	6	7
The CPR system is easily accessible anywhere on the hospital Intranet	1	2	3	4	5	6	7
Use of CPR system required a lot of mental effort	1	2	3	4	5	6	7
When I finish entering the data it is fast to generate CPR card	1	2	3	4	5	6	7
CPR system design is pretty and attractive	1	2	3	4	5	6	7
It scares me to think that I could lose a lot of information using the CPR system by hitting the wrong key	1	2	3	4	5	6	7
I hesitate to use CPR system for fear of making mistakes I cannot correct	1	2	3	4	5	6	7
I feel apprehensive (anxious) about using the CPR system.	1	2	3	4	5	6	7
I find using the CPR system to be enjoyable.	1	2	3	4	5	6	7
The actual process of using the CPR system is pleasant.	1	2	3	4	5	6	7
I have fun using the CPR system.	1	2	3	4	5	6	7
All my colleagues use the CPR system.	1	2	3	4	5	6	7
The senior nurses can check if I am using of the system.	1	2	3	4	5	6	7
In general, the hospital has supported the use of the CPR system.	1	2	3	4	5	6	7
Using the CPR system is mandatory in this process.	1	2	3	4	5	6	7
I think about the CPR system as the first step when I need to do calculation.	1	2	3	4	5	6	7
There are other ways I can do the calculation I prefer.	1	2	3	4	5	6	7
My colleagues in the hospitals respect me for using advanced system.	1	2	3	4	5	6	7

My colleagues in other hospitals respect me for using advanced system.	1	2	3	4	5	6	7
Using CPR system makes me distinctive from others at the hospital	1	2	3	4	5	6	7
I have the resources necessary to use the CPR system, for printing etc.	1	2	3	4	5	6	7
When I face problem during the use of CPR system, I find the technical support available all time	1	2	3	4	5	6	7
In general, the nursing administration has supported the use of the CPR system	1	2	3	4	5	6	7
I find the CPR system intuitive and does not need prolonged training.	1	2	3	4	5	6	7
Suitable training is available for me	1	2	3	4	5	6	7
My level of understanding was substantially improved after going through the training programme	1	2	3	4	5	6	7
Given the resources, opportunities and knowledge it takes to use the system, it would be easy for me to use the CPR system.	1	2	3	4	5	6	7
The CPR system is integrated with other systems I use.	1	2	3	4	5	6	7
All the functions in the CPR system are related to the job.	1	2	3	4	5	6	7
Some functions in the CPR system require me to add unnecessary tasks.	1	2	3	4	5	6	7
The functions in the CPR system covers all the tasks needed for this job.	1	2	3	4	5	6	7
The quality of the output I get from the CPR system is high.	1	2	3	4	5	6	7
I have no problem with the quality of the CPR system's output.	1	2	3	4	5	6	7
I rate the results from the CPR system to be excellent.	1	2	3	4	5	6	7
I have no difficulty telling others about the results of using the CPR system.	1	2	3	4	5	6	7
I believe I could communicate to others the consequences of using the CPR system.	1	2	3	4	5	6	7
The results of using the CPR system are apparent to me.	1	2	3	4	5	6	7
I would have difficulty explaining why using the CPR system may or may not be beneficial.	1	2	3	4	5	6	7
Assuming I had access to the CPR system, I intend to use it.	1	2	3	4	5	6	7
Given that I had access to the CPR system, I predict that I would use it.	1	2	3	4	5	6	7
I plan to use CPR system in the future.	1	2	3	4	5	6	7
Did CPR nursing manager collected your feedback during the system development	1	2	3	4	5	6	7
Did your feedback has an impact on CPR changes	1	2	3	4	5	6	7
Were a high percentage of nurses feedbacks considered in CPR changes?	1	2	3	4	5	6	7
Did CPR manager encourage you to report CPR feedbacks	1	2	3	4	5	6	7
Did you receive an appreciation when you report any feedback	1	2	3	4	5	6	7
Your department supports training for new employees run by a professional trainer.	1	2	3	4	5	6	7
Your department provides the training for employee whenever there is important on the system/technology (such as CPR system).	1	2	3	4	5	6	7

Please circle the most appropriate box of each statement which corresponds most closely to your desired response.

On an average, how much time do you need to generate a CPR card?	Less than 1 Min	Form 2-4 Min	From 5-14 Min	From 15 - 30 Min	More 30- 1 H	More 1-2 H	More than 2 H
On average, how frequently do you use CPR system?	Not at all	Less than once a month	Once a month	a few times a month;	A few times a week	About once a day	Several times a day
I would rate the intensity of my job related the CPR system use to be …	Extremely light	Moderately light	Somewhat light	Neither light nor heavy	Somewhat heavy	Moderately heavy	Extremely heavy
The time which is assigned to complete the training is	Less than 1 Hrs	From 1-4 Hrs	From 8-16 Hrs	From 16-32 Hrs	From 2 – 4 days	From 4 to 6 days	More than 1 Week
I believe/perceive that the system is or will be…	Important in accomplishing tasks.	Valuable to the organization.	Interesting to me	Good for all concerned	Wanted by other individuals.		

The following questions are about your confidence when using CPR systems/ (Please answer YES (with scale 1-7) or just NO) in circle:

I will be able to complete a task using CPR system ...	**Yes →** (Confident)	**Not at All**			**Moderately**			**Totally**
... if there was no one around to tell me what	**No**	1	2	3	4	5	6	7
... if I had just the built-in help facility for assistance	**No**	1	2	3	4	5	6	7
... if someone showed me how to do it first	**No**	1	2	3	4	5	6	7
... if I had used similar packages before this one to do the same job	**No**	1	2	3	4	5	6	7

The following questions ask you how you would characterize yourself when you use CPR system:

	Strongly Disagree	**Moderately Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Moderately Agree**	**Strongly Agree**
. . . spontaneous	1	2	3	4	5	6	7
. . . creative	1	2	3	4	5	6	7
. . . playful	1	2	3	4	5	6	7
. . . unoriginal (boring)	1	2	3	4	5	6	7

==================THANK YOU =====================

Appendix E Nurtal System Questionnaire

Questionnaire:

Part I: Demographic data:

The questionnaire is anonymous; this means it will not be possible to identify you or link any responses to you. Please circle the most appropriate number of each statement which corresponds most closely to your desired response.

1. **Age:**

   ☐ 20-30 years ☐ 31-40 years ☐ 41-50 years ☐ >51 years

2. **Gender:** ☐ Male ☐ Female

3. **Nationality:** ☐ Saudi ☐ Filipino

   ☐ Indian ☐ Other, specify_______________

4. **Years of experience:**

   ☐ Less than 1 Year ☐ 1-2 Years

   ☐ 3-5 Years ☐ More than 5 Years

5. **Level of education:**

   ☐ Master in Nursing ☐ Doctor in Nursing

   ☐ Diploma in Nursing ☐ Bachelor in Nursing

6. **Job title:**

   ☐ Charge Nurse ☐ Nursing Team

   ☐ Staff Nurse 1 ☐ Staff Nurse 2

1

Part II: TAM 3

Please, indicate your level of agreement with the following statements, where 1 is extremely disagree and 7 is extremely agree (put one circle in each line). Some of questions may appear similar, but there are actually subtle differences in what is being asked. Your opinions and perceptions are valued.

	Strongly Disagree	Moderately Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Moderately Agree	Strongly Agree
Comparing to the manual scanning (Konica), NURTAL system reduces the time needed to send inpatient prescription form (IPPF)	1	2	3	4	5	6	7
NURTAL system reduces the need to call pharmacy to confirm receiving the IPPF	1	2	3	4	5	6	7
NURTAL system reduces the need to call pharmacy to follow up the IPPF	1	2	3	4	5	6	7
Scanning function in NURTAL system reduces the chance of data entry errors	1	2	3	4	5	6	7
Comparing to the manual scanning (Konica), NURTAL provide more useful features.	1	2	3	4	5	6	7
NURTAL system eases the tracking of my IPPF inside the pharmacy.	1	2	3	4	5	6	7
NURTAL system accelerates receiving the feedback from pharmacy in case of any comment from pharmacy (rejection).	1	2	3	4	5	6	7
NURTAL documents all communications with pharmacy.	1	2	3	4	5	6	7
I find the NURTAL system to be useful in my job	1	2	3	4	5	6	7
Information display is clear and understandable.	1	2	3	4	5	6	7
The NURTAL system data entry is easy and visible.	1	2	3	4	5	6	7
The NURTAL system is easily accessible anywhere on the hospital Intranet.	1	2	3	4	5	6	7
Use of NURTAL system required a lot of mental effort.	1	2	3	4	5	6	7
When I finish entering the data it is easy to send IPPF	1	2	3	4	5	6	7
NURTAL system design is pretty and attractive.	1	2	3	4	5	6	7
It scares me to think that I could lose a lot of information using the NURTAL system by hitting the wrong key	1	2	3	4	5	6	7
I hesitate to use NURTAL system for fear of making mistakes I cannot correct	1	2	3	4	5	6	7
I feel apprehensive (anxious) about using the NURTAL system.	1	2	3	4	5	6	7
The NURTAL system is somewhat frightening to me.	1	2	3	4	5	6	7
I find using the NURTAL system to be enjoyable.	1	2	3	4	5	6	7
The actual process of using the NURTAL system is pleasant.	1	2	3	4	5	6	7
I have fun using the NURTAL system.	1	2	3	4	5	6	7

All my colleagues use the NURTAL system.	1	2	3	4	5	6	7
The senior nurses can check if I am using of the NURTAL system.	1	2	3	4	5	6	7
The senior nurses have been helpful in the use of the NURTAL system.	1	2	3	4	5	6	7
In general, the hospital has supported the use of the NURTAL system.	1	2	3	4	5	6	7
Using the NURTAL system is mandatory in this process.	1	2	3	4	5	6	7
I think about the NURTAL system as the first step when I need to communicate with pharmacy.	1	2	3	4	5	6	7
There are other ways I can do to communication with pharmacy I prefer.	1	2	3	4	5	6	7
My supervisor does not require me to use the NURTAL system.	1	2	3	4	5	6	7
My colleagues in the hospitals respect me for using advanced system.	1	2	3	4	5	6	7
My colleagues in other hospitals respect me for using advanced system.	1	2	3	4	5	6	7
Using NURTAL system makes me distinctive from others at the hospital.	1	2	3	4	5	6	7
I have the resources necessary to use the NURTAL system, e.g. Zebra printer etc.	1	2	3	4	5	6	7
When I face problem during the use of NURTAL system, I find the technical support available all time.	1	2	3	4	5	6	7
In general, the nursing administration has supported the use of the NURTAL system	1	2	3	4	5	6	7
Given the resources, opportunities and knowledge it takes to use the system, it would be easy for me to use the NURTAL system.	1	2	3	4	5	6	7
The NURTAL system is integrated with other systems I use.	1	2	3	4	5	6	7
All the functions in the NURTAL system are related to the job.	1	2	3	4	5	6	7
Some functions in the NURTAL system require me to add unnecessary tasks.	1	2	3	4	5	6	7
The functions in the NURTAL system covers all the tasks needed for this job.	1	2	3	4	5	6	7
NURTAL eases the accessibility to patients' laboratory results.	1	2	3	4	5	6	7
The quality of the output I get from the NURTAL system is high.	1	2	3	4	5	6	7
I have no problem with the quality of the NURTAL system's output.	1	2	3	4	5	6	7
I rate the results from the NURTAL system to be excellent.	1	2	3	4	5	6	7
I have no difficulty telling others about the results of using the NURTAL system.	1	2	3	4	5	6	7
I believe I could communicate to others the consequences of using the NURTAL system.	1	2	3	4	5	6	7
The results of using the NURTAL system are apparent to me.	1	2	3	4	5	6	7
I would have difficulty explaining why using the NURTAL system may or may not be beneficial.	1	2	3	4	5	6	7
Assuming I had access to the NURTAL system, I intend to use it.	1	2	3	4	5	6	7
Given that I had access to the NURTAL system, I predict that I would use it.	1	2	3	4	5	6	7
I plan to use NURTAL system in the future.	1	2	3	4	5	6	7
Did NURTAL system manager collected your feedback during the system development	1	2	3	4	5	6	7

Did your feedback has an impact on NURTAL changes	1	2	3	4	5	6	7
Did NURTAL system manager encourage you to report NURTAL feedbacks	1	2	3	4	5	6	7
Did you receive an appreciation when you report any feedback	1	2	3	4	5	6	7
Suitable training is available for me.	1	2	3	4	5	6	7
I find the NURTAL system intuitive and does not need prolonged training.	1	2	3	4	5	6	7
My level of understanding was substantially improved after going through the training programme.	1	2	3	4	5	6	7
Your department supports training for new employees run by a professional trainer.	1	2	3	4	5	6	7
Your department provides the training for employee whenever there is important on the system/technology (such as NURTAL system).	1	2	3	4	5	6	7

Please circle the most appropriate box of each statement which corresponds most closely to your desired response.

On an average working day, how frequently do you use NURTAL system?	Almost never	Less than 1/2 hour	From 1/2 - 4 hour	4 - 6 hours	6 – 8 hours	8 -10 hours	More than 10 H
On average, how much time do you usually spend using NURTAL system?	Once every three months	Less than once a month	Once a month	A few times a month	A few times a week	About once a day	Several times a day
I can describe the NURTAL system to be	Extremely light	Moderately light	Somewhat light	Neither light nor heavy	Somewhat heavy	Moderately heavy	Extremely heavy

The following questions are about your confidence when using NURTAL systems/ (Please answer YES (with scale 1-7) or just NO) in circle:

		Yes (Level of confidence)						
	No	**Totally**			**Moderately**			**Totally**
I will be able to complete a task using NURTAL system, if there was no one around to tell me what	0	1	2	3	4	5	6	7
I will be able to complete a task using NURTAL system, if I had just the built-in help facility for assistance	0	1	2	3	4	5	6	7
I will be able to complete a task using NURTAL system, if someone showed me how to do it first	0	1	2	3	4	5	6	7
I will be able to complete a task using NURTAL system, if I had used similar packages before this one to do the same job	0	1	2	3	4	5	6	7

The following questions ask you <u>how you would characterize yourself when you use NURTAL system</u>:

	Strongly Disagree	Moderately Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Moderately Agree	Strongly Agree
. . . spontaneous	1	2	3	4	5	6	7
. . . creative	1	2	3	4	5	6	7
. . . playful	1	2	3	4	5	6	7
. . . unoriginal (boring)	1	2	3	4	5	6	7

Any comments or suggestions:

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==================== T H A N K Y O U ======================

Appendix F Pharmtal System Questionnaire

Questionnaire:

Part I: Demographic data:

The questionnaire is anonymous; this means it will not be possible to identify you or link any responses to you. Please circle the most appropriate number of each statement which corresponds most closely to your desired response.

1. **Age:**

☐ 20-30 years ☐ 31-40 years ☐ 41-50 years ☐ >51 years

2. **Gender:** ☐ Male ☐ Female

3. **Nationality:** ☐ Saudi ☐ Non-Saudi, specify______________

4. **Years of experience:**

☐ Less than 1 Year ☐ 1-2 Years

☐ 3-5 Years ☐ More than 5 Years

5. **Level of education:**

☐ Bachelor degree ☐ PharmD ☐ Residency (R1, R2)

☐ Master degree ☐ R3 ☐ Doctor degree (PhD)

6. **Location**

☐ B5 (Main building) ☐ B2 (VIP building) ☐ B4 (new tower)

☐ B8 (Emergency Pharmacy)

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Part II: TAM 3

Please, indicate your level of agreement with the following statements, where 1 is extremely disagree and 7 is extremely agree (put one circle in each line). Some of questions may appear similar, but there are actually subtle differences in what is being asked. Your opinions and perceptions are valued.

	Strongly Disagree	**Moderately Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Moderately Agree**	**Strongly Agree**
Comparing to the manual scanning (Konica), PHARMATAL system is easer to find and sort the inpatient prescription form (IPPF)	1	2	3	4	5	6	7
PHARMATAL system reduces the need to receive a call from nurses to confirm receiving the IPPF	1	2	3	4	5	6	7
PHARMATAL system reduces the need to receive a call from nurses to follow up the IPPF	1	2	3	4	5	6	7
PHARMATAL system reduces the chance of misreading of medical record number due to illegible hand writing	1	2	3	4	5	6	7
Comparing to the manual scanning (Konica), PHARMATAL provide more useful features.	1	2	3	4	5	6	7
When I profile the medications in mainframe, it is easy to change the status of prescription to "profiled" to inform the nurse about the status of prescription.	1	2	3	4	5	6	7
PHARMATAL system eases tracking of the IPPF inside the pharmacy.	1	2	3	4	5	6	7
When I need to send feedback (rejection) to nurse, PHARMATAL system accelerates the process.	1	2	3	4	5	6	7
I find the PHARMATAL system to be useful in my job	1	2	3	4	5	6	7
Information display on PHARMATAL is clear and understandable.	1	2	3	4	5	6	7
The PHARMATAL system data entry is easy and visible.	1	2	3	4	5	6	7
The PHARMATAL system is easily accessible anywhere on the hospital Intranet.	1	2	3	4	5	6	7
Use of PHARMATAL system required a lot of mental effort.	1	2	3	4	5	6	7
PHARMATAL documents all communications with nursing	1	2	3	4	5	6	7
PHARMATAL system design is pretty and attractive.	1	2	3	4	5	6	7
It scares me to think that I could lose a lot of information using the PHARMATAL system by hitting the wrong key	1	2	3	4	5	6	7
I hesitate to use PHARMATAL system for fear of making mistakes I cannot correct	1	2	3	4	5	6	7
I feel apprehensive (anxious) about using the PHARMATAL system.	1	2	3	4	5	6	7

The PHARMATAL system is somewhat frightening to me.	1	2	3	4	5	6	7
I find using the PHARMATAL system to be enjoyable.	1	2	3	4	5	6	7
The actual process of using the PHARMATAL system is pleasant.	1	2	3	4	5	6	7
I have fun using the PHARMATAL system.	1	2	3	4	5	6	7
All my colleagues use the PHARMATAL system.	1	2	3	4	5	6	7
The senior pharmacist can check if I am using of the PHARMATAL system.	1	2	3	4	5	6	7
The senior pharmacist has been helpful in the use of the PHARMATAL system.	1	2	3	4	5	6	7
In general, the hospital has supported the use of the PHARMATAL system	1	2	3	4	5	6	7
Using the PHARMATAL system is mandatory in this process.	1	2	3	4	5	6	7
I think about the PHARMATAL system as the first step when I need to communicate with nurses.	1	2	3	4	5	6	7
While there are many other way to communicate the nurse ways I prefer use PHARMATAL	1	2	3	4	5	6	7
My supervisor does not require me to use the PHARMATAL system.	1	2	3	4	5	6	7
My colleagues in the hospitals respect me for using advanced system.	1	2	3	4	5	6	7
My colleagues in other hospitals respect me for using advanced system.	1	2	3	4	5	6	7
Using PHARMATAL system makes me distinctive from others at the hospital.	1	2	3	4	5	6	7
I have the resources necessary to use the PHARMATAL system, e.g. monitors, printers etc.	1	2	3	4	5	6	7
When I face problem during the use of PHARMATAL system, I find the technical support available all time	1	2	3	4	5	6	7
In general, the pharmacy administration has supported the use of the PHARMATAL system	1	2	3	4	5	6	7
Given the resources, opportunities and knowledge it takes to use the system, it would be easy for me to use the PHARMATAL system.	1	2	3	4	5	6	7
The PHARMATAL system is integrated with other systems I use.	1	2	3	4	5	6	7
All the functions in the PHARMATAL system are related to the job.	1	2	3	4	5	6	7
Some functions in the PHARMATAL system require me to add unnecessary tasks.	1	2	3	4	5	6	7
The functions in the PHARMATAL system covers all the tasks needed for this job.	1	2	3	4	5	6	7
PHARMATAL eases the accessibility to patients' laboratory results	1	2	3	4	5	6	7
The quality of the output I get from the PHARMATAL system is high.	1	2	3	4	5	6	7
I have no problem with the quality of the PHARMATAL system's output.	1	2	3	4	5	6	7
I rate the results from the PHARMATAL system to be excellent.	1	2	3	4	5	6	7
I have no difficulty telling others about the results of using the PHARMATAL system.	1	2	3	4	5	6	7
I believe I could communicate to others the consequences of using the PHARMATAL system.	1	2	3	4	5	6	7

The results of using the PHARMATAL system are apparent to me.	1	2	3	4	5	6	7
I would have difficulty explaining why using the PHARMATAL system may or may not be beneficial.	1	2	3	4	5	6	7
Assuming I had access to the PHARMATAL system, I intend to use it.	1	2	3	4	5	6	7
Given that I had access to the PHARMATAL system, I predict that I would use it.	1	2	3	4	5	6	7
I plan to use PHARMATAL system in the future.	1	2	3	4	5	6	7
Did PHARMATAL system manager collected your feedback during the system development.	1	2	3	4	5	6	7
Did your feedback has an impact on PHARMATAL changes	1	2	3	4	5	6	7
Did PHARMATAL system manager encourage you to report PHARMATAL feedbacks	1	2	3	4	5	6	7
Did you receive an appreciation when you report any feedback	1	2	3	4	5	6	7
Suitable training is available for me.	1	2	3	4	5	6	7
I find the PHARMATAL system intuitive and does not need prolonged training.	1	2	3	4	5	6	7
My level of understanding was substantially improved after going through the training programme	1	2	3	4	5	6	7
Your department supports training for new employees run by a professional trainer.	1	2	3	4	5	6	7
Your department provides the training for employee whenever there is important on the system/technology (such as PHARMATAL system).	1	2	3	4	5	6	7

Please circle the most appropriate box of each statement which corresponds most closely to your desired response.

On an average working day, how much time do you usually spend using PHARMATAL system?	Almost never	Less than 1/2 hour	From 1/2 - 4 hour	4 - 6 hours	6 – 8 hours	8 -10 hours	10-12 hours
On average, how frequently do you use PHARMATAL system?	Once every three months	Less than once a month	Once a month	A few times a month	A few times a week	About once a day	Several times a day
I can describe the PHARMATAL system to be …	Extreme ly light	Moderately light	Somewha t light	Neither light nor heavy	Somewh at heavy	Moder ately heavy	Extreme ly heavy

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The following questions are about your confidence when using PHARMATAL systems / (Please answer YES (with scale 1-7) or just NO) in circle:

	No	**Yes (Level of confidence)**						
		Totally			**Moderately**			**Totally**
I will be able to complete a task using PHARMATAL system, if there was no one around to tell me what to do as I go	0	1	2	3	4	5	6	7
I will be able to complete a task using PHARMATAL system, if I had just the built-in help facility for assistance	0	1	2	3	4	5	6	7
I will be able to complete a task using PHARMATAL system, if someone showed me how to do it first	0	1	2	3	4	5	6	7
I will be able to complete a task using PHARMATAL system, if I had used similar packages before this one to do the same job	0	1	2	3	4	5	6	7

The following questions ask you <u>how you would characterize yourself when you use PHARMATAL system</u>:

	Strongly Disagree	**Moderately Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Moderately Agree**	**Strongly Agree**
. . . spontaneous	1	2	3	4	5	6	7
. . . creative	1	2	3	4	5	6	7
. . . playful	1	2	3	4	5	6	7
. . . unoriginal (boring)	1	2	3	4	5	6	7

Any comments or suggestions (You can write in Arabic or English):**تستطيع كتابة التعليق باللغة العربية او الانجليزية**

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==================THANK YOU ====================

Appendix G CPR Survey Result

Part I: Demographic data

Questions	participants' answers					Grand total
Q1	20-30 years	31-40 years	41-50 years	>51 years		281
	67.02%	17.02%	12.06%	3.90%		
	188	48	34	11		
Q2	Male		Female			281
	6.03%		93.97%			
	17		264			
Q3	Saudi	Filipino	Indian	Jordanian		281
	17.38%	78.37%	3.90%	0.35%		
	49	220	11	1		
Q4	Less than a year	1-2 Years	3-5 Years	More than 5 Years		281
	14.89%	24.82%	24.11%	36.17%		
	42	70	68	101		
Q5	Diploma in Nursing	Bachelor in Nursing	Master in Nursing	Doctor in Nursing		281
	10.64%	87.23%	1.77%	0.35%		
	30	245	5	1		
Q6	Head Nurse	Charge Nurse	Nursing Team Leader	Staff Nursing 1	Staff Nursing 2	281
	0.35%	5.67%	2.84%	23.40%	67.73%	
	1	16	8	66	190	

Part II: TAM 3:

Que	**participants' answers**							**Grand total**
Q7	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.42%	3.19%	0.35%	10.64%	7.80%	19.15%	57.45%	
	4	9	1	30	22	54	161	
Q8	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.42%	2.48%	1.42%	6.74%	8.51%	25.53%	53.90%	
	4	7	4	19	24	72	151	
Q9	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.06%	2.84%	1.06%	7.45%	10.99%	24.11%	52.48%	
	3	8	3	21	31	68	147	

Q10	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.06%	3.19%	0.00%	7.80%	6.74%	21.63%	59.57%	
	3	9	0	22	19	61	167	
Q11	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.06%	1.06%	1.42%	3.90%	6.03%	18.79%	67.73%	
	3	3	4	11	17	53	190	
Q12	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.42%	2.13%	0.71%	5.32%	6.38%	22.70%	61.35%	
	4	6	2	15	18	64	172	
Q13	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.06%	1.06%	1.42%	5.67%	7.80%	24.82%	58.16%	
	3	3	4	16	22	70	163	
Q14	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.42%	2.84%	2.48%	6.03%	10.28%	29.08%	47.87%	
	4	8	7	17	29	82	134	
Q15	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	8.87%	7.09%	7.45%	21.63%	12.77%	19.86%	22.34%	
	25	20	21	61	36	56	62	
Q16	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.06%	3.19%	2.48%	8.16%	8.87%	26.95%	49.29%	
	3	9	7	23	25	76	138	
Q17	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	0.71%	2.13%	2.13%	14.89%	16.31%	30.14%	33.69%	
	2	6	6	42	46	85	94	
Q18	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	7.45%	4.61%	6.74%	22.70%	20.92%	23.05%	14.54%	
	21	13	19	64	59	64	41	

Q19	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	16.31%	13.12%	14.54%	21.63%	13.12%	15.25%	6.03%	
	46	37	41	60	37	43	17	
Q20	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	21.99%	13.83%	14.18%	23.76%	12.06%	8.51%	5.67%	
	62	39	40	66	34	24	16	
Q21	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.77%	1.42%	2.13%	25.18%	21.99%	22.70%	24.82%	
	5	4	6	71	62	64	69	
Q22	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.77%	1.42%	1.06%	13.48%	21.99%	32.62%	27.66%	
	5	4	3	38	62	91	78	
Q23	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	2.84%	1.77%	2.13%	22.70%	19.50%	26.60%	24.47%	
	8	5	6	64	55	75	68	
Q24	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.42%	0.71%	2.13%	8.87%	9.57%	23.05%	54.26%	
	4	2	6	25	27	65	152	
Q25	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.77%	1.77%	2.84%	15.25%	14.18%	23.05%	41.13%	
	5	5	8	43	40	65	115	
Q26	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	0.35%	2.13%	1.06%	8.51%	11.35%	25.89%	50.71%	
	1	6	3	24	32	73	142	
Q27	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	0.71%	1.78%	2.14%	8.19%	10.32%	27.40%	49.47%	
	2	5	6	23	29	77	139	

Q28	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.78%	2.85%	1.78%	15.30%	13.17%	33.10%	32.03%	
	5	8	5	43	37	93	90	
Q29	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	7.12%	4.27%	5.69%	29.18%	16.73%	23.49%	13.52%	
	20	12	16	82	47	66	38	
Q30	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.07%	2.49%	1.42%	15.30%	13.52%	25.62%	40.57%	
	3	7	4	43	38	72	114	
Q31	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.42%	3.20%	1.07%	16.01%	12.81%	30.96%	34.52%	
	4	9	3	45	36	87	97	
Q32	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	0.71%	2.14%	2.85%	17.08%	15.66%	31.67%	29.89%	
	2	6	8	48	44	89	84	
Q33	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.78%	1.78%	3.20%	11.74%	18.51%	28.47%	34.52%	
	5	5	9	33	52	80	97	
Q34	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.42%	6.76%	8.54%	21.35%	18.15%	24.91%	18.86%	
	4	19	24	60	51	70	53	
Q35	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	0.71%	1.78%	1.78%	11.74%	9.96%	29.89%	44.13%	
	2	5	5	33	28	84	124	
Q36	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	0.36%	2.14%	1.07%	9.61%	13.88%	35.23%	37.72%	
	1	6	3	27	39	99	106	

Q37	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	3.20%	1.07%	2.14%	15.30%	15.66%	33.45%	29.18%	
	9	3	6	43	44	94	82	
Q38	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.42%	1.07%	1.78%	9.25%	11.39%	34.16%	40.93%	
	4	3	5	26	32	96	115	
Q39	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	7.12%	5.69%	6.05%	22.42%	16.01%	27.76%	14.95%	
	20	16	17	63	45	78	42	
Q40	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	0.71%	2.14%	1.78%	12.46%	19.22%	33.10%	30.60%	
	2	6	5	35	54	93	86	
Q41	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	0.36%	1.42%	1.07%	8.19%	15.66%	39.50%	33.81%	
	1	4	3	23	44	111	95	
Q42	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	0.71%	2.14%	1.78%	9.25%	15.66%	37.01%	33.45%	
	2	6	5	26	44	104	94	
Q43	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	0.36%	1.78%	0.36%	11.39%	11.74%	37.37%	37.01%	
	1	5	1	32	33	105	104	
Q44	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	0.36%	2.14%	1.42%	11.03%	11.39%	35.94%	37.72%	
	1	6	4	31	32	101	106	
Q45	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	0.36%	1.78%	1.78%	9.25%	16.37%	34.16%	36.30%	
	1	5	5	26	46	96	102	

Q46	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	0.36%	1.42%	0.36%	12.10%	14.59%	38.08%	33.10%	
	1	4	1	34	41	107	93	
Q47	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	8.90%	7.12%	7.12%	22.78%	13.88%	23.13%	17.08%	
	25	20	20	64	39	65	48	
Q48	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.07%	1.42%	1.07%	8.90%	18.86%	29.18%	39.50%	
	3	4	3	25	53	82	111	
Q49	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.07%	2.14%	1.07%	9.96%	17.44%	33.81%	34.52%	
	3	6	3	28	49	95	97	
Q50	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	1.07%	1.42%	1.07%	7.83%	13.17%	32.74%	42.70%	
	3	4	3	22	37	92	120	
Q51	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	3.56%	3.91%	4.98%	17.79%	14.23%	31.32%	24.20%	
	10	11	14	50	40	88	68	
Q52	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	3.56%	2.14%	4.63%	19.57%	16.73%	31.32%	22.06%	
	10	6	13	55	47	88	62	
Q53	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	3.56%	2.49%	4.27%	22.78%	14.95%	29.89%	22.06%	
	10	7	12	64	42	84	62	
Q54	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281
	3.91%	2.85%	3.20%	27.05%	17.44%	26.33%	19.22%	
	11	8	9	76	49	74	54	

Q55	Less than 1 Min	Form 2-4 Mins	From 5-14 Mins	From 15-30 Mins	More 30-1 H	More 1-2 H	More 1-2 H	More than 2 H	281
	36.30%	46.62%	8.90%	4.63%	2.14%	0.36%	0.71%	0.36 %	
	102	131	25	13	6	1	2	1	
Q56	Not at all	Less than once a month	Once a month	A few times a month	A few times a week	about once a day	Several times a day	281	
	5.34%	11.74%	6.05%	10.68%	13.88%	17.79%	34.52%		
	15	33	17	30	39	50	97		
Q57	Extremely light	Moderately light	Somewhat light	Neither light nor heavy	Somewhat heavy	Moderately heavy	Extremely heavy	281	
	21.35%	27.40%	18.51%	12.10%	3.20%	7.83%	9.61%		
	60	77	52	34	9	22	27		
Q60	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281	
	1.42%	3.20%	3.56%	15.66%	16.73%	31.32%	28.11%		
	4	9	10	44	47	88	79		
Q61	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281	
	1.07%	1.42%	1.78%	12.81%	12.46%	36.30%	34.16%		
	3	4	5	36	35	102	96		
Q62	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281	
	1.42%	2.14%	2.14%	12.10%	16.37%	35.23%	30.60%		
	4	6	6	34	46	99	86		
Q63	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281	
	1.07%	3.56%	1.78%	17.79%	16.37%	33.45%	25.98%		
	3	10	5	50	46	94	73		
Q64	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	281	
	1.42%	2.14%	1.78%	14.23%	15.30%	33.81%	31.32%		
	4	6	5	40	43	95	88		
Q65	Less than 1 Hours	From 1-4 Hours	From 8-16 Hours	From 16-32 Hours	From 2 – 4 days	From 4 day to 6 days	More than 1 W	281	
	56.94%	27.05%	6.05%	2.49%	3.20%	2.85%	1.42%		
	160	76	17	7	9	8	4		

Q58

#	No		Not at All						Mode						Totally		Total
1	3.91%	11	6.41%	18	4.63%	13	4.98%	14	33.45%	94	8.19%	23	11.74%	33	26.69%	75	281
2	3.20%	9	5.34%	15	6.05%	17	6.41%	18	29.89%	84	10.32%	29	15.30%	43	23.49%	66	281
3	2.85%	8	5.34%	15	3.20%	9	4.98%	14	30.96%	87	7.47%	21	15.30%	43	29.89%	84	281
4	6.05%	17	3.91%	11	4.63%	13	4.27%	12	32.38%	91	7.12%	20	13.88%	39	27.76%	78	281

Q59

#	Strongly Disagree		Moderately Disagree		Somewhat Disagree		Neutral		Somewhat Agree		Moderately Agree		Strongly Agree		Total
1	2.14%	6	1.42%	4	2.85%	8	17.79%	50	11.03%	31	29.18%	82	35.59%	100	281
2	1.42%	4	2.14%	6	2.49%	7	22.06%	62	14.59%	41	28.47%	80	28.83%	81	281
3	7.12%	20	3.20%	9	3.56%	10	30.60%	86	11.74%	33	24.56%	69	19.22%	54	281
4	23.84%	67	9.25%	26	13.17%	37	24.20%	68	10.32%	29	8.90%	25	10.32%	29	281

Appendix H Nurtal System Survey Result

Part I: Demographic data:

Questions	participants' answers					Grand total
Q1	20-30 years	31-40 years	41-50 years	>51 years		471
	60.93%	26.33%	10.83%	1.91%		
	287	124	51	9		
Q2	Male		Female			471
	14.23%		85.77%			
	67		404			
Q3	Saudi		Non-Saudi			471
Q4	Less than a year	1-2 Years	3-5 Years	More than 5 Years		471
	9.13%	27.60%	27.60%	35.67%		
	43	130	130	168		
Q5	Diploma in Nursing	Bachelor in Nursing	Master in Nursing	Doctor in Nursing		471
	6.16%	92.57%	1.27%	0.00%		
	29	436	6	0		
Q6	Head Nurse	Charge Nurse	Nursing Team Leader	Staff Nursing 1	Staff Nursing 2	471
	0.21%	2.12%	1.06%	16.77%	79.83%	
	1	10	5	79	376	

Part II: TAM 3:

Que	Participants' answers							Gra
Q7	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	1.70%	1.49%	4.46%	19.75%	16.14%	30.36%	26.11%	
	8	7	21	93	76	143	123	
Q8	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	2.97%	2.34%	7.22%	15.29%	19.11%	31.63%	21.44%	
	14	11	34	72	90	149	101	
Q9	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	4.25%	3.40%	7.64%	16.56%	22.72%	29.51%	15.92%	
	20	16	36	78	107	139	75	
Q10	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471

	1.27%	0.64%	3.61%	19.11%	22.29%	34.61%	18.47%	
	6	3	17	90	105	163	87	
Q11	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.64%	1.06%	1.49%	15.29%	19.11%	38.43%	23.99%	
	3	5	7	72	90	181	113	
Q12	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.64%	1.49%	3.18%	9.34%	22.93%	38.22%	24.20%	
	3	7	15	44	108	180	114	
Q13	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	1.91%	1.49%	3.18%	12.74%	21.02%	36.31%	23.35%	
	9	7	15	60	99	171	110	
Q14	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.21%	1.06%	4.88%	12.10%	18.05%	33.12%	30.57%	
	1	5	23	57	85	156	144	
Q15	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.21%	1.06%	1.91%	13.38%	20.17%	36.52%	26.75%	
	1	5	9	63	95	172	126	
Q16	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.21%	1.27%	3.18%	12.74%	19.96%	36.09%	26.54%	
	1	6	15	60	94	170	125	
Q17	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.00%	0.42%	2.34%	13.59%	20.17%	37.58%	25.90%	
	0	2	11	64	95	177	122	
Q18	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.64%	1.49%	4.88%	15.92%	19.96%	35.03%	22.08%	
	3	7	23	75	94	164	104	
Q19	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	5.52%	5.52%	11.25%	24.42%	25.05%	19.53%	8.70%	

	26	26	53	115	118	92	41	
Q20	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.21%	1.27%	3.18%	17.83%	21.87%	31.00%	24.63%	
	1	6	15	84	103	146	116	
Q21	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.85%	1.70%	2.55%	26.96%	22.51%	28.24%	17.20%	
	4	8	12	127	106	133	81	
Q22	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	7.43%	4.67%	12.53%	32.27%	24.63%	15.92%	2.55%	
	35	22	59	152	116	75	12	
Q23	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	14.23%	8.28%	18.05%	31.42%	15.29%	10.83%	1.91%	
	67	39	85	148	72	51	9	
Q24	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	24.84%	12.74%	14.65%	24.42%	12.10%	10.19%	1.06%	
	117	60	69	115	57	48	5	
Q25	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	32.06%	14.23%	16.14%	21.66%	7.43%	6.58%	1.91%	
	151	67	76	102	35	31	9	
Q26	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	2.34%	2.12%	6.16%	35.03%	22.72%	21.44%	10.19%	
	11	10	29	165	107	101	48	
Q27	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.85%	1.49%	4.67%	28.45%	26.75%	27.81%	9.98%	
	4	7	22	134	126	131	47	
Q28	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	1.70%	2.34%	4.03%	34.18%	24.84%	23.78%	9.13%	
	8	11	19	161	117	112	43	

Q29	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.64%	0.85%	2.12%	8.49%	14.23%	25.05%	48.62%	
	3	4	10	40	67	118	229	
Q30	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.42%	1.27%	3.61%	14.86%	17.41%	30.36%	32.06%	
	2	6	17	70	82	143	151	
Q31	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.42%	0.85%	2.12%	14.23%	19.53%	31.21%	31.63%	
	2	4	10	67	92	147	149	
Q32	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.42%	0.64%	1.70%	14.86%	19.11%	30.57%	32.70%	
	2	3	8	70	90	144	154	
Q33	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.85%	0.42%	1.06%	12.74%	17.83%	26.75%	40.34%	
	4	2	5	60	84	126	190	
Q34	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	1.91%	0.64%	1.27%	13.80%	22.72%	27.60%	32.06%	
	9	3	6	65	107	130	151	
Q35	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	2.97%	4.03%	6.37%	29.94%	22.93%	22.72%	11.04%	
	14	19	30	141	108	107	52	
Q36	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	45.22%	9.98%	9.34%	9.98%	9.77%	10.83%	4.88%	
	213	47	44	47	46	51	23	
Q37	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	1.70%	0.85%	1.91%	23.14%	17.83%	30.79%	23.78%	
	8	4	9	109	84	145	112	

Q38	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	1.27%	1.27%	2.55%	25.69%	19.53%	27.60%	22.08%	
	6	6	12	121	92	130	104	
Q39	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	1.49%	1.27%	3.18%	22.51%	23.35%	27.18%	21.02%	
	7	6	15	106	110	128	99	
Q40	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	1.49%	2.12%	3.82%	15.71%	19.96%	30.15%	26.75%	
	7	10	18	74	94	142	126	
Q41	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	9.34%	8.28%	11.46%	25.90%	20.59%	15.71%	8.70%	
	44	39	54	122	97	74	42	
Q42	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.21%	1.27%	1.91%	20.59%	22.72%	28.45%	24.84%	
	1	6	9	97	107	134	117	
Q43	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.00%	0.85%	2.12%	19.75%	20.59%	32.06%	24.63%	
	0	4	10	93	97	151	116	
Q44	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.64%	1.27%	3.82%	19.32%	24.20%	31.00%	19.75%	
	3	6	18	91	114	146	93	
Q45	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.21%	1.27%	1.49%	14.01%	22.29%	32.06%	28.66%	
	1	6	7	66	105	151	135	
Q46	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	3.18%	4.25%	8.92%	27.18%	25.48%	21.66%	9.34%	
	15	20	42	128	120	102	44	

Q47	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	1.06%	2.76%	3.82%	23.35%	27.18%	27.39%	14.44%	
	5	13	18	110	128	129	68	
Q48	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	2.76%	1.70%	7.22%	22.08%	22.93%	30.79%	12.53%	
	13	8	34	104	108	145	59	
Q49	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.64%	1.49%	4.25%	22.51%	23.14%	35.24%	12.74%	
	3	7	20	106	109	166	60	
Q50	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	1.06%	1.49%	7.22%	23.57%	25.48%	31.42%	9.77%	
	5	7	34	111	120	148	46	
Q51	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.85%	1.06%	5.31%	20.81%	26.75%	32.70%	12.53%	
	4	5	25	98	126	154	59	
Q52	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.42%	1.70%	4.25%	21.44%	28.03%	30.36%	13.80%	
	2	8	20	101	132	143	65	
Q53	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.64%	1.27%	4.03%	21.66%	30.79%	30.36%	11.25%	
	3	6	19	102	145	143	53	
Q54	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.42%	1.27%	3.61%	23.99%	26.11%	29.30%	15.29%	
	2	6	17	113	123	138	72	
Q55	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	6.79%	5.94%	9.77%	31.00%	19.11%	18.90%	8.49%	
	32	28	46	146	90	89	40	

Q56	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.85%	1.70%	0.85%	17.41%	25.05%	30.15%	23.99%	
	4	8	4	82	118	142	113	
Q57	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	1.06%	0.85%	1.70%	17.41%	25.05%	30.79%	23.14%	
	5	4	8	82	118	145	109	
Q58	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.85%	0.64%	1.91%	15.92%	20.81%	32.06%	27.81%	
	4	3	9	75	98	151	131	
Q59	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	4.46%	3.18%	4.46%	19.32%	27.18%	24.42%	16.99%	
	21	15	21	91	128	115	80	
Q60	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	1.91%	1.27%	4.46%	29.51%	22.29%	28.24%	12.31%	
	9	6	21	139	105	133	58	
Q61	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	2.12%	2.12%	5.73%	24.63%	24.84%	26.11%	14.44%	
	10	10	27	116	117	123	68	
Q62	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	4.46%	4.46%	8.07%	32.06%	19.96%	20.59%	10.40%	
	21	21	38	151	94	97	49	
Q63	Almost never	Less than 1/2 hour	From 1/2 - 4 hour	4 - 6 hours	6 – 8 hours	8 -10 hours	More than 10 H	471
	0.64%	14.44%	25.48%	18.47%	9.77%	9.34%	21.87%	
	3	68	120	87	46	44	103	
Q64	Once every three months	Less than once a month	Once a month	A few times a month	A few times a week	about once a day	Several times a day	471
	0.42%	0.64%	0.21%	0.85%	5.10%	7.64%	85.14%	
	2	3	1	4	24	36	401	

Q65	Extremely light	Moderately light	Somewhat light	Neither light nor heavy	Somewhat heavy	Moderately heavy	Extremely heavy	471
	11.89%	30.36%	27.39%	17.41%	6.16%	5.10%	1.70%	
	56	143	129	82	29	24	8	
Q68	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	1.49%	2.34%	4.88%	27.39%	26.33%	26.54%	11.04%	
	7	11	23	129	124	125	52	
Q69	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.21%	1.27%	3.82%	23.14%	24.20%	32.27%	15.07%	
	1	6	18	109	114	152	71	
Q70	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.42%	0.42%	1.91%	22.08%	25.05%	33.76%	16.35%	
	2	2	9	104	118	159	77	
Q71	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.64%	1.06%	2.76%	24.63%	24.20%	31.21%	15.50%	
	3	5	13	116	114	147	73	
Q72	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	471
	0.00%	1.27%	4.25%	23.99%	23.35%	29.72%	17.41%	
	0	6	20	113	110	140	82	

Q66

#	No		Not at All						Mod						Totally		Total
1	5.31%	25	4.46%	21	3.40%	16	1.91%	9	26.96%	127	10.62%	50	16.77%	79	30.57%	144	471
2	4.88%	23	4.25%	20	3.82%	18	4.67%	22	29.09%	137	13.38%	63	15.92%	75	23.99%	113	471
3	3.61%	17	5.52%	26	3.61%	17	3.40%	16	22.29%	105	14.01%	66	18.26%	86	29.30%	138	471

4	4.03%	19	3.82%	18	3.18%	15	4.25%	20	28.24%	133	13.59%	64	20.59%	97	22.29%	105	471

Q67

#	Strongly Disagree		Moderately Disagree		Somewhat Disagree		Neutral		Somewhat Agree		Moderately Agree		Strongly Agree		Total
1	0.85%	4	0.64%	3	1.49%	7	18.90%	89	16.99%	80	31.00%	146	30.15%	142	471
2	1.06%	5	1.06%	5	1.91%	9	25.48%	120	18.90%	89	32.06%	151	19.53%	92	471
3	7.01%	33	2.55%	12	3.61%	17	35.24%	166	17.62%	83	22.72%	107	11.25%	53	471
4	19.53%	92	7.64%	36	14.65%	69	34.39%	162	7.86%	37	10.83%	51	5.10%	24	471

Appendix I Pharmtal System Survey Result

Part I: Pharmtal System Demographic data:

Questions	participants' answers						Grand total
Q1	20-30 years	31-40 years	41-50 years	>51 years			47
	%61.7	%23.4	%10.6	%4.2			
	29	11	5	2			
Q2	Male		Female				47
	%59.6		%40.4				
	19		28				
Q3	Saudi		Sudanese				47
	%76.60		%23.4				
	36		11				
Q4	Less than a year	1-2 Years	3-5 Years	More than 5 Years			47
	%10.6	24.19%	19.35%	43.55%			
	5	12	9	21			
Q5	Bachelor Degree	Pharm D	Residency (R1, R2)	Master Degree	R3	Doctor Degree	47
	%59.5	%27.6	%4.2	%6.3	0.00%	%2.1	
	28	13	2	3	0	1	
Q6	B5 (Main building)	B2 (VIP building)	B4 (New tower)	B8 (Emergency Pharmacy)			47
	41.94%	32.26%	6.45%	19.35%			
	21	16	2	8			

Part II: Pharmtal System TAM 3:

Que	Participants' Answers							T
Q7	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.69%	0.00%	0.00%	0.00%	1.69%	35.59%	61.02%	
	1	0	0	0	1	21	23	
Q8	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	3.39%	11.86%	5.08%	6.78%	16.95%	30.51%	25.42%	
	2	6	3	4	10	10	12	
Q9	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	5.08%	22.03%	10.17%	5.08%	16.95%	23.73%	16.95%	
	3	10	6	3	7	11	7	

Q10	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	5.08%	5.08%	5.08%	1.69%	13.56%	32.20%	37.29%	
	3	3	3	1	7	14	16	
Q11	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.69%	0.00%	0.00%	3.39%	10.17%	47.46%	37.29%	
	1	0	0	2	6	21	17	
Q12	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.69%	0.00%	1.69%	3.39%	6.78%	55.93%	30.51%	
	1	0	1	2	4	24	15	
Q13	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	3.39%	0.00%	1.69%	1.69%	6.78%	47.46%	38.98%	
	2	0	1	1	4	21	18	
Q14	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	3.39%	0.00%	1.69%	0.00%	15.25%	38.98%	40.68%	
	2	0	1	0	8	17	19	
Q15	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.69%	0.00%	0.00%	1.69%	16.95%	37.29%	42.37%	
	1	0	0	1	8	17	20	
Q16	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.72%	0.00%	1.72%	5.17%	8.62%	56.90%	25.86%	
	1	0	1	3	5	24	13	
Q17	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.72%	1.72%	0.00%	5.17%	10.34%	51.72%	29.31%	
	1	1	0	3	5	24	13	
Q18	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.72%	0.00%	0.00%	6.90%	10.34%	46.55%	34.48%	
	1	0	0	4	5	20	17	

Q19	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	8.62%	36.21%	5.17%	8.62%	18.97%	17.24%	5.17%	
	4	16	3	4	9	8	3	
Q20	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.72%	5.17%	5.17%	8.62%	20.69%	32.76%	25.86%	
	1	3	3	4	12	15	12	
Q21	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.72%	5.17%	6.90%	20.69%	22.41%	31.03%	12.07%	
	1	3	4	9	10	14	6	
Q22	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	7.14%	33.93%	5.36%	10.71%	19.64%	17.86%	5.36%	
	4	15	3	5	9	8	3	
Q23	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	16.07%	39.29%	12.50%	5.36%	17.86%	5.36%	3.57%	
	8	17	6	3	8	3	2	
Q24	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	19.64%	57.14%	1.79%	5.36%	7.14%	8.93%	0.00%	
	9	25	1	3	4	5	0	
Q25	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	23.21%	53.57%	7.14%	7.14%	3.57%	5.36%	0.00%	
	11	23	4	4	2	3	0	
Q26	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	3.70%	1.85%	20.37%	24.07%	42.59%	7.41%	
	0	2	1	9	11	20	4	
Q27	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	0.00%	0.00%	14.81%	31.48%	46.30%	7.41%	
	0	0	0	7	14	22	4	

Q28	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	7.41%	3.70%	24.07%	29.63%	27.78%	7.41%	
	0	4	2	11	14	12	4	
Q29	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	0.00%	0.00%	1.85%	5.56%	48.15%	44.44%	
	0	0	0	1	3	23	20	
Q30	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	1.85%	1.85%	1.85%	1.85%	53.70%	38.89%	
	0	1	1	1	1	25	18	
Q31	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	3.70%	1.85%	5.56%	5.56%	55.56%	27.78%	
	0	2	1	3	3	25	13	
Q32	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	3.70%	5.56%	3.70%	20.37%	35.19%	31.48%	
	0	2	3	2	9	17	14	
Q33	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	1.85%	0.00%	3.70%	5.56%	62.96%	25.93%	
	0	1	0	2	3	28	13	
Q34	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	14.81%	3.70%	11.11%	20.37%	29.63%	20.37%	
	0	7	2	5	10	13	10	
Q35	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.85%	12.96%	3.70%	5.56%	22.22%	29.63%	24.07%	
	1	6	2	3	10	14	11	
Q36	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	40.74%	48.15%	1.85%	5.56%	1.85%	1.85%	0.00%	
	19	22	1	3	1	1	0	

Q37	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	5.56%	7.41%	1.85%	20.37%	11.11%	33.33%	20.37%	
	3	4	1	10	5	15	9	
Q38	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	7.41%	12.96%	0.00%	18.52%	14.81%	22.22%	24.07%	
	3	6	0	9	7	10	12	
Q39	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	5.56%	7.41%	5.56%	33.33%	11.11%	20.37%	16.67%	
	2	3	2	17	5	10	8	
Q40	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	3.77%	0.00%	0.00%	3.77%	24.53%	35.85%	32.08%	
	2	0	0	2	11	17	15	
Q41	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	15.09%	15.09%	9.43%	15.09%	22.64%	9.43%	13.21%	
	7	7	4	7	12	4	6	
Q42	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	0.00%	1.89%	1.89%	11.32%	47.17%	37.74%	
	0	0	1	1	5	22	18	
Q43	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.89%	3.77%	0.00%	5.66%	5.66%	56.60%	26.42%	
	1	2	0	3	3	27	11	
Q44	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	3.77%	9.43%	9.43%	13.21%	18.87%	33.96%	11.32%	
	2	4	4	6	9	17	5	
Q45	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	1.92%	0.00%	1.92%	7.69%	63.46%	25.00%	
	0	1	0	1	3	31	11	

Q46	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	9.62%	26.92%	26.92%	19.23%	17.31%	17.31%	0.00%	
	4	13	4	10	8	8	0	
Q47	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	11.54%	15.38%	3.85%	19.23%	38.46%	11.54%	
	0	6	7	2	9	17	6	
Q48	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.92%	11.54%	3.85%	5.77%	11.54%	46.15%	19.23%	
	1	5	2	3	5	23	9	
Q49	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	3.85%	0.00%	7.69%	11.54%	17.31%	42.31%	17.31%	
	2	0	4	6	8	19	8	
Q50	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.92%	0.00%	9.62%	17.31%	23.08%	30.77%	17.31%	
	1	0	5	8	11	14	8	
Q51	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	0.00%	5.77%	9.62%	30.77%	34.62%	19.23%	
	0	0	3	5	14	16	9	
Q52	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	1.92%	1.92%	15.38%	7.69%	50.00%	23.08%	
	0	1	1	8	4	22	11	
Q53	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	1.92%	7.69%	9.62%	9.62%	55.77%	15.38%	
	0	1	4	5	5	25	8	
Q54	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	0.00%	1.92%	5.77%	21.15%	51.92%	19.23%	
	0	0	1	3	10	24	9	

Q55	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	5.77%	48.08%	7.69%	13.46%	7.69%	15.38%	1.92%	
	3	20	4	7	4	8	1	
Q56	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	3.85%	0.00%	5.77%	3.85%	57.69%	28.85%	
	0	2	0	3	2	26	14	
Q57	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	1.92%	1.92%	7.69%	11.54%	50.00%	26.92%	
	0	1	1	4	6	22	13	
Q58	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.92%	1.92%	7.69%	15.38%	3.85%	36.54%	32.69%	
	1	1	4	7	2	17	15	
Q59	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	1.92%	0.00%	7.69%	17.31%	13.46%	46.15%	13.46%	
	1	0	4	8	7	20	7	
Q60	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	0.00%	5.77%	19.23%	15.38%	46.15%	13.46%	
	0	0	3	9	8	20	7	
Q61	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	1.92%	3.85%	11.54%	7.69%	53.85%	21.15%	
	0	1	2	6	4	24	10	
Q62	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	7.69%	17.31%	5.77%	21.15%	11.54%	28.85%	7.69%	
	4	8	3	10	6	12	4	
Q63	Almost never	Less than 1/2 hour	From 1/2 - 4 hour	4 - 6 hours	6 – 8 hours	8 -10 hours	More than 10 H	47
	1.92%	0.00%	3.85%	13.46%	75.00%	5.77%	0.00%	
	1	0	2	7	34	3	0	

Q64	Once every three months	Less than once a month	Once a month	A few times a month	A few times a week	about once a day	Several times a day	47
	1.92%	0.00%	0.00%	3.85%	9.62%	3.85%	80.77%	
	1	0	0	2	5	2	37	
Q65	Extremely light	Moderately light	Somewhat light	Neither light nor heavy	Somewhat heavy	Moderately heavy	Extremely heavy	47
	15.38%	28.85%	21.15%	13.46%	13.46%	3.85%	3.85%	
	7	12	10	7	7	2	2	
Q68	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	2.13%	8.51%	6.38%	10.64%	19.15%	40.43%	12.77%	
	1	4	3	5	9	19	6	
Q69	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	8.51%	4.26%	6.38%	21.28%	46.81%	12.77%	
	0	4	2	3	10	22	6	
Q70	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	2.13%	6.38%	19.15%	17.02%	48.94%	6.38%	
	0	1	3	9	8	23	3	
Q71	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	0.00%	12.77%	8.51%	14.89%	19.15%	29.79%	14.89%	
	0	6	4	7	9	14	7	
Q72	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree	47
	4.26%	4.26%	2.13%	14.89%	25.53%	38.30%	10.64%	
	2	2	1	7	12	18	5	
Q73	Less than 1 Hours	From 1-4 Hours	From 8-16 Hours	From 16-32 Hours	From 2-4 days	From 4 day to 6 days	More than 1 W	47
	36.17%	17.02%	6.38%	2.13%	6.38%	19.15%	12.77%	
	17	8	3	1	3	9	6	

Q66

#	No		Not at All						Moderately						Totally		Total
1	10.20%	5	6.12%	3	4.08%	2	0.00%	0	26.53%	13	6.12%	3	2.04%	1	44.90%	20	47
2	14.29%	7	8.16%	4	2.04%	1	0.00%	0	32.65%	16	8.16%	4	10.20%	5	24.49%	10	47
3	24.49%	12	4.08%	2	4.08%	2	0.00%	0	18.37%	9	10.20%	5	6.12%	3	32.65%	14	47
4	30.61%	14	8.16%	4	4.08%	2	2.04%	1	26.53%	12	8.16%	4	4.08%	2	16.33%	8	47

Q67

#	No		Not at All		.		.		Moderately		.		.		Totally		Total
1	10.20%	5	6.12%	3	4.08%	2	0.00%	0	26.53%	13	6.12%	3	2.04%	1	44.90%	22	49
2	14.29%	7	8.16%	4	2.04%	1	0.00%	0	32.65%	16	8.16%	4	10.20%	5	24.49%	12	49
3	24.49%	12	4.08%	2	4.08%	2	0.00%	0	18.37%	9	10.20%	5	6.12%	3	32.65%	16	49
4	30.61%	15	8.16%	4	4.08%	2	2.04%	1	26.53%	13	8.16%	4	4.08%	2	16.33%	8	49

Q68

#	Strongly Disagree		Moderately Disagree		Somewhat Disagree		Neutral		Somewhat Agree		Moderately Agree		Strongly Agree		Total
1	0.00%	0	2.04%	1	2.04%	1	32.65%	16	6.12%	3	20.41%	10	36.73%	18	49
2	0.00%	0	0.00%	0	8.16%	4	32.65%	16	16.33%	8	22.45%	11	20.41%	10	49
3	28.57%	14	0.00%	0	12.24%	6	30.61%	15	8.16%	4	8.16%	4	12.24%	6	49
4	20.41%	10	6.12%	3	14.29%	7	44.90%	22	6.12%	3	4.08%	2	4.08%	2	49

Appendix J Nurtal System – Nurses Feedback

Table 134 comments or suggestion was received from Nurtal questionnaire

Acceptance/ Rejection	Technical Problem	Organisational	Environmental	Suggestion
Acceptance	Not send fax it by Konica **(6 Times)**	Train New Nurses	Hopefully all STAT, ASAP requests can be supply without the nurse going to pharmacy to get the medicine. **(2 Times)**	Direct to computer communication. No need to fax through Nurtal. Develop system to give orders to order via computer system then print only the MAR for signing. Thank you.
Nurtal became **helpful** and made **easier** for nurses **(15 Times)**	System Down a lot/Sometimes **(10 Times)**	Continuous Training	You have to follow it up with the pharmacy and they will ask us to send it again. **(8 Times)**	In the acknowledgment of rejection- there should be a room (box) for nurses to answer back the rejection reason of the pharmacy. This will save time in refaxing the medication.
Saving Nurses Time	Previous **design** of Nurtal is better than the one we're using now.	Training should be reinforced every month or quarterly	The system depends in the pharmacy how they arrange/process the request.	In the surgery list/ theatre list (if he is 1st or 2nd)- case# should also be included - so the nurses would be guided in managing their time. not just the theatre room number. **(7 Times)**
Easy to communicate with the pharmacy staff	Somewhat/Not friendly **design** (compared new to the last design)	Training should be provided first to operate it before use the system	If pharmacy commit an error in data entry, they ask the nurses to refax with IPPF	Printing/modify of laboratory results should be easier. Print button should be available without the need to copy and paste. **(5 Times)**
Nice job well done for having updated system.	**New design:** take time to have a feedback from the pharmacy	Train the pharmacist **(5 Times)**		Blood results sometimes you cannot access and print.
Great future	Needs more Zebra machine especially ED departments /at least 2 Zebras/computer **(15 Times)**	The only problem is the pharmacist / staff it takes a lot of time to see the result if sent/not sent/ rejected. **(5 Times)**		Orientation for some features for fast use of Nurtal like (MAR / Lab results).

Application itself is okay **(2 Times)**	Only one computer that is connected to a Zebra printer. **(4 Times)**	Pharmacy should respond as quick as they can comment should be displayed not just write rejected**. (Give Reasons) (9 Times)**		Needs more option
Easy to use **(8 Times)**	Zebra printer (Out of sticker or carbon paper) **(3 Times**)	Pharmacy dept. they **ignore/long time** some of our request even the STAT one. **(Needs response fast) (9 Times)**		Please return back the requisition of case notes
Paperless	Takes time to send manually most especially weekends. **(2 Times)**	Pharmacy should be accessible at times for correction		For pharmacy let them have a clerk to input all the medications prescribe in IPPF.
Attractive	Sometimes that the Zebra printer in the station is not working **(5 Times)**	Pharmacy takes time to respond when we call for clarification **(2 Times)**		
Nurtal system is good/very good **(2 Times)**	Need the Nurtal to be program in all the computer in the ward so that it will be accessible for the nurses use. **(15 Times)**	There are some instances that the medication faxed to be discontinued or hold, or even asking for refill or renew was different from the MAR that received. Kindly check carefully to reduce the time spent on sending another / faxing again just to get the desired MAR for correct medication. For example: " Cephalosporin faxed to be discontinued but the one discontinued is Cefazolin." **(2 Times)**		Doing " acknowledge" should be along with medication entry profile it is difficult for the nurses to go with rejection request profile and acknowledge and pharmacy response with the request is delaying sometimes.
Nurtal is good but depends on the department how they respond to it, especially the Pharmacy dept.	if could change the colour to much better, and to change the appearance of font to nice one it helps me to do the job very week in such way.	Comment portion should be read and understand/ understood by the receiving staff of the pharmacies. Confusion of the pharmacy staff should be communicated		

		immediately to the sender. **(2 Times)**		
Not complicated.	Take time to fix	Needs number of the technician in pharmacy to contact		
No problem	Fix/maintain the Nurtal/ Printers **(9 Times)**	Technical support should be prompt in attending to our calls. **(3 Times)**		
great	No way of knowing if it is really not working since sometimes it only says not sent.	IT should always be available help during " NIght" and "weekends" 24/7. **(11 Times)**		
Accessible **(3 Times)**	Sometimes takes too long to load (home page and all)	Need to have full manpower in pharmacy but still there's a - 24hrs not only in the daytime, it should have 24/7, every shift to transcribe faxed IPPF, dispensing pharmacists **(3 Times)**		
Communicate	The repairing of Konica machines	Delay to provide MAR and supply medication after faxing **(2 Times)**		
Useful	Most of times have difficulty in entering data.	Pharmacists are somewhat lacking of endorsement during change of shift.		
No question about Nurtal system	Nurtal used by nurses and doctors usage. If you can provide one computer separately for nurses only which is more appreciable.	Still need to improve on the pharmacy staff, sometime they do not know the meaning of what is being asked, requested in the remarks.		
very good to trace the error esp. in medication	Laboratory results should be updated early.	Sometimes it is indicated in the Nurtal that the medication we faxed is already received but he pharmacy are telling us they didn't receive any requests.		
Very comfortable access	Nurtal sometime/always not working **(13 Times)**	When I called the pharmacy, they said its written in the		

		computer the reasons for rejection.		
Work Harmoniously.	Needs more Konica **(5 Times)**	Hope when the system is down the pharmacy will be friendly enough to communication		
<u>Rejection</u>	MAR print should be similar with mainframe, we never use it because its not the same in the mainframe, too small when you print it.	Additional workload to nurses regarding input of medications in the system that supposed to be a job for the pharmacist not the nurses.		
Additional **workload** to nurses regarding input of medications in the system that supposed to be a job for the pharmacist not the nurses.	No/Slow Intranet **(6 Times)**	Should add more staff for the pharmacy/IT **(2 Times)**		
	System is very **slow/weak (2 Times)**	I think we are using our time (1/3rd of our duty time) to use for following it up the indications. **(2 Times)**		
	There must be a light orientation or discussion how to use and trouble shoot the Nurtal (Guide)	Sometime pharmacy is giving as MAR with wrong medications, wrong dose and wrong route. (Always wrong MAR) **(2 Times)**		
	Konica sometime/always/overworked not working **(7 Times)**	Delays mostly are caused by **pharmacy staff**		
	Needs More PC **(6 Times)**	More staff in the pharmacy that are efficient enough		
	Difficult to print radiologic result	The pharmacist is also not approachable and lazy to profile.		
	Update of the information on Nurtal	Pharmacy is the problem not the Nurtal		

	Nurses who who are waiting for their turn to enter it.	Pharmacy staff courteous enough to cater nurses needs in getting medication.		
	Showing the radiology images is not available.	Sometimes the attitude of pharmacist are not that good.		
	Allergies, if (unknown) counts as 1 on the system			
	Lack of monitoring team			
	Should the ward/informed ahead of time if Nurtal is not working. **(2 Times)**			
	If system is down, it consumes a lot of time wasting **(2 Times)**			
	The new Nurtal format is somewhat lagging/hanging **(2 Times)**			
	medication prepared by pharmacist not guaranteed			
	Printer sometimes is not clear			
	Change Konica			

Appendix K Pharmatal System – Pharmacists Feedback

Table the raw comments for pharmacists received during Pharmatal questionnaire survey

Participants	Comment
Comment 1	I hope this message finds you well. First of all I want to say thank you for your effort that's really Improve our health care and facilitate any difficulties that we face, we all noticed the improvements and this encourage us to do our best. Thank you.
Comment 2	I think outcome will be more when Pharmatal training and understanding be completed for both nurse and pharmacist, I think we phase problem with nurse calling and following till this moment, and from our side we have small problem that’s when we reject any order we cannot change the status or send any note back to change your document in Pharmatal as you discover that is wrong decision
Comment 3	Fixing the network in the hospital is important in the process. For us as well for the nurses to minimise manual prescription.
Comment 4	Pharmatal easy to use but need more education to nurses because until now call and ask the order send or no it's take time to check if send or no. And some nurse call and told me I send order but no MAR when I check the state of order not send and some nurse not know how send order he told I send many time write no send in Pharmatal can prink manual. Also, the main problem for me if Pharmatal not working (down) The only way to know that the Pharmatal is not working is when orders delayed and the problem that we don't have other way to know, faster than that. And ITE not answer quickly I hope if have any way to know quickly like Pyxis appear red colour also I hope if Pharmatal stop send alert to ward (nurses) instead of call all ward and also this way to stop nurses to send order by Pharmatal because after Pharmatal open appear all old order it is take time to check if prepare or no. I hope if have cell in Pharmatal for (diagnosis of patient) and bleep of Doctor because in IPPF not clear. Also, I hope to contact with other pharmacy by Pharmatal because some medication not available in pharmacy It is taken time other pharmacy to answer especially in evening shift.
Comment 5	Connect Pharmatal to profiling system MCR communication need more update connection to Konica makes a lot of failure.
Comment 6	Still the Pharmatal system add a lot of improvement the pharmacy system, but there more and advanced system available now at the market.
Comment 7	Pharmital is very useful and I can feel a lot of benefits and a lot of modifications done in the system since we started. Only one point I wish to add: if I get an order IPPF containing say 5 items (e.g.) and by mistake I profiled item No 2 instead of 3 but item 2 should be rejected I can't change the profiled status in the Pharmatal
Comment 8	Thanks for giving me the chance, kindly I would like to suggest if we can add Micromedex access to Pharmatal, this would help us on performing our tasks and MCR specially more professionally with time reduction and high level of confidence, and it will unified reference for all the staff, before we had the access for all the staff on their smart phone, now I had communicate with the drug information if the renew the subscription because it had been expired, unfortunately it's not and they suggested another

	trusted reference app that give 3 month free trial , appreciating all your efforts to enhance the system and overall improvement, thanks with kind regards.
Comment 9	About MCR if it can be electronic and to be reported
Comment 10	We receive unnecessary calls from the nurses following the request without seeing the status is it send or not send is it profiled or not and if there any rejection they can't read it because they don't know how Pharmatal is very good system but it's hangs sometimes thank you
Comment 11	I hope that in the near future the IPPF doesn't need to be scanned and will be electronic
Comment 12	Being a great system, still continuous telephone calls from Nurses is annoying and causing delay in adequate work performance.
Comment 13	No option to find an order by reference number - If someone reject an order by mistake, he can't change the status back to profiled
Comment 14	Improve MCR performance and Lab results
Comment 15	I would like to comment about the communication with the nurses through Pharmatal when any prescription is rejected, regardless the availability of rejection reason in the P harmatal the majority of nurse still calling the pharmacy to know the reason without checking the system. The pharmacy still receives many calls mainly in the evening after the implementation of the system. I suggest to add drug-drug interaction feature to the system to check any interaction between drugs and disease. The abbreviations should be prohibited as the majority write the abbreviations of diagnosis. I believe the responsibility of drug allergy documentation into the patient file should be moved from pharmacists to nurses because the nurse is the healthcare provided who is the most close to the patients as well as the pharmacist is the last stage in the process of medication use process therefore, it is unreasonable to let the patient passes through all these processes and the majority unaware of this matter.

Appendix L Ethics Approval

Ethics approval for CPR and Nurtal/Pharmtal systems

M.S.D.

PRINCE SULTAN MILITARY MEDICAL CITY

P.O. Box 7897, Riyadh 11159
Kingdom of Saudi Arabia

RESEARCH CENTER

Research Ethics Committee
(Reg. # HAP-01-R-015)

31 March 2016

DR. MOHAMMED ALMEZINY
Clinical Pharmacist
Department of Pharmaceutical Services

Re: Reduce the time and potential errors in CPR medications using a CPR calculator in pediatric wards

This is in reference to your submitted proposal which has been reviewed by the appointed members of the committee through an expedited review process. On the recommendation of the board of review on the ethical aspects of the proposal, Research Ethics Committee is pleased to approve and grant permission to conduct your study.

Your research protocol has been documented under:

Project No.	776
Date Approved	30 March
Series of	2016

Kindly quote the project number indicated herein in all transactions and communications. You are advised to submit a report in relation to this research scheme to update the committee of its progress.

Also, please note that this approval is valid only for one year commencing from the date of this letter.

I trust your research scheme proves fruitful and beneficial to the PSMMC.

Best regards,

DR. SAEED KADASAH
Chairman, Research Ethics Committee
First Floor, Building 15

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M.S.D.

MEDICAL SERVICES DEPARTMENT FOR ARMED FORCES

SCIENTIFIC RESEARCH CENTER

Research Ethics Committee, Central Region

(Reg. # HAP-01-R-015)

03 April 2016

COL. DR. MOHAMMAD ALMEZINY
Director, Pharmaceutical Services
Prince Sultan Military Medical City

Re: Using an integrated information system to reduce interruptions and number of non-relevant contacts in the inpatient pharmacy at tertiary hospital

This is in reference to your submitted proposal which has been reviewed by the appointed members of the committee through an expedited review process. On the recommendation of the board of review on the ethical aspects of the proposal, Research Ethics Committee is pleased to approve and grant permission to conduct your study.

Your research protocol has been documented under:

Project No.	1003
Date Approved	03 April
Series of	2016

Kindly quote the project number indicated herein in all transactions and communications. You are advised to submit a report in relation to this research scheme to update the committee of its progress.

Also, please note that this approval is valid only for one year commencing from the date of this letter.

I trust your research scheme proves fruitful and beneficial to the central region military hospitals.

Best regards,

DR. SAEED KADASAH
Chairman, Research Ethics Committee
First Floor, Building 15 (PSMMC)

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